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GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

Canada. Geological Survey

SUMMARY REPORT

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OF THE

OPERATIONS of the GEOLOGICAL and NATURAL HISTORY SURVEY

THE GEOGRAPHICAL SOCIETY OF THE PACIFIC
PROPERTY OF

To 31st December, 1886

BEING

PART III

ANNUAL REPORT OF THE DEPARTMENT OF THE INTERIOR,

1886.

OTTAWA:
PRINTED BY MacLEAN, ROGER & CO., WELLINGTON STREET.
1887

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GEOLOGICAL SURVEY.

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DEPARTMENT OF THE INTERIOR,
GEOLOGICAL AND NATURAL HISTORY SURVEY AND MUSEUM BRANCH,
OTTAWA, 31st December, 1886.

To the Hon. THOS. WHITE,
Minister of the Interior,
Ottawa.

SIR,—The customary annual summary report on the progress of the work of the Geological and Natural History Branch of the Department of the Interior is submitted herewith.

It will be found somewhat to exceed in length previous summary reports, but with a view to meeting the demand for early publication of results it is deemed advisable to incorporate the main outlines of these in so far as they relate to mining and other industries and also as regards the case of explorations, the final results of which cannot be published in a satisfactory form before the completion of further field work.

It will be observed that during the past season the field work was in progress in eleven districts, and that in some of these in addition to the work by the head of the party independent work was simultaneously in progress by one or more assistants.

Especial thanks are due from the Survey to Mr. Joseph Wrigley, Chief Commissioner of the Hudson Bay Company, for letters to the officers at the various posts visited by the parties working in the region north of Lake Superior and around Hudson Bay, and also to the officers themselves for their uniform kindness and valuable assistance in various ways.

On the 9th of February I left Ottawa for England to superintend the unpacking and arrangement of the collections sent to illustrate the mineral, vegetable and animal resources of the Dominion at the Colonial and Indian Exhibition. I arrived in London on the 22nd of February, and a few weeks later I was joined by my colleagues, Messrs. Macoun, Adams and Willimott.

In reference to some of the practical results which may be expected, or have already arisen from the work of the Exhibition, the following facts may be mentioned:—

Plumbago—Enquiries were constantly being made about this mineral by persons from various parts of the United Kingdom, as well as from the continent They were referred to the various exhibitors, whose addresses were given them.

Mica.—A number of enquiries as above.

Soapstone.—Two or three gentlemen who are very anxious to find localities from which they can get continuous supplies of good soapstone were given samples of ours, which gave such satisfaction that one gentleman ordered five tons to make further trials, and they have all promised to report on the qualities of the samples supplied them, and will state in what essential the stone is deficient. The precise article required by the trade will thus be ascertained, and a considerable business in this material will, in all probability, be developed.

Asbestus.—There was a fine exhibit of this mineral; much attention was attracted by it, and many enquiries made concerning it. Several asbestos properties were sold as a result of the information given. These various refractory minerals attracted especial attention.

Chrome Iron Ore.—Samples of several of the specimens exhibited were sent to large consumers for examination. It was found that some would sell for about £4 stg. a ton in Glasgow, while others which were not sufficiently rich to pay for

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exportation might be made so by a process of careful selection, or by the ore improving in depth. Now that the Eastern Townships have greatly increased railroad facilities and it being ascertained that this mineral will bring remunerative prices, it will doubtless ere long be largely exported.

The gold and silver ores of British Columbia, Ontario, Nova Scotia and Quebec also attracted much attention. As a result of the exhibition several mines have been sold, and preparations are being made for working others. Reports from the Port Arthur district show that a direct impetus has been given to gold and silver mining in that district by the Exhibition.

In this connection another very valuable result of the Exhibition is that some firms in England have made arrangements to purchase and concentrate the tailings of the principal Nova Scotia gold mines, shipping the concentrate to England for treatment. This is also a benefit to England, as this kind of work has heretofore been carried on almost entirely in Germany.

Iron Ores.—The Iron and Steel Institute made a careful examination of the various iron ores and coals of the colonies and India represented in the Exhibition and issued a report on their iron-making resources. Out of a total of 137 pages no less than 69 or one-half of the whole was devoted to Canada, and much attention was in this way drawn to our iron ores which were very highly spoken of. "It requires," the report says, "no great degree of prophetic instinct to see that before long Canada, India, New South Wales, New Zealand, and Queensland are destined to become in a greater or less degree friendly rivals with us in competing for their own and neighboring markets." The members of the Institute subsequently, after the reading of the report, visited the Exhibition and examined the ores and fuels. The ores from British Columbia, which are in proximity to coal, have been the especial objects of enquiry, and it is stated that large works for the production of iron and steel will shortly be erected in that province.

A mining engineer called and asked to see our samples of these ores, as he was about to leave for British Columbia to erect iron works, &c., to cost some three million dollars.

Manganese.—Many enquires were made about this mineral, and the addresses of the producers in Canada were given.

Petroleum.—Experts who were found to be much prejudiced against Canadian oil say that the samples shown them were as good as could be desired and quite free from bad smell. The Exhibition will, no doubt, help to remove this prejudice.

Ochres.—Samples were sent by request to various large consumers who will examine them and report on the prices they would bring in the English market.

Slate.—Rockland slate and slate manufactures were very highly commended, and said to compare very favorably with the best qualities of Welsh and Scotch slate.

Rocks.—There were many enquires about Canadian granites and marbles. The red granites and the grey Arnprior marbles were much admired; and it is expected that business will be done in New Brunswick granite.

Agates, &c.—Enquiries have also been made by several firms who manufacture agate goods, respecting the agates from Nova Scotia and Lake Superior. The addresses of persons who could supply them were given. The Huronian red jasper conglomerate also attracted much attention and enquiry.

Phosphate.—The attention directed to this mineral by the fine specimens exhibited—the only ones in the Exhibition—has given an impetus to this industry, and resulted in the sale of several properties.

Reports, &c.—The special Descriptive Catalogue of the Economic Minerals of Canada, already referred to, was widely distributed at the Exhibition. Detailed articles on the mineral wealth of the Dominion appeared in many of the principal papers and magazines. Lectures were given in the conference room on the natural resources of the Dominion, both mineral, vegetable and animal, while during the whole period of the Exhibition either Professor Macoun, Mr. Adams, Mr. Willimott or I was in attendance to answer the many enquiries which were daily being made respecting the climate, the geography, the geology and the natural productions of the country.

My best thanks are due to my colleagues above named for their hearty and zealous co-operation and valuable assistance in the work above referred to, and in arranging the large quantity of material which had to be dealt with, in such a manner as to make a successful and attractive display of the varied resources of the Dominion.

After the close of the Exhibition, on the 10th of November,—except a few specimens that had to be returned to their respective owners—the whole of the minerals and some of the natural history specimens were packed up, to be made over to the authorities who represent the interests of the proposed Imperial and Colonial Institute. The valuable collection of birds and other animals, purchased or supplied from the Museum collection, were all carefully packed to be returned to Ottawa, where they will be properly cared for, and be available for future exhibitions.

During my absence in England in connection with the Colonial and Indian Exhibition, from the 9th of February to the 22nd of December, Dr. G. M. Dawson has superintended the work of the survey as Acting Director, and his time was so fully occupied in attending to the shipment of the mineral exhibits, in work connected with the preparation of the special catalogue, printed subsequently under my superintendence in London, in editing the annual volume of Survey Reports, in completing and publishing his own report on a portion of the Rocky Mountains, in making preliminary arrangements connected with the collection and compilation of mineral and mining statistics, and in the general routine and office duties, that he found it impossible to undertake any work in the field. I wish here to record my high appreciation of the very able and efficient manner in which Dr. Dawson has performed all the work above referred to.

The collection of insects purchased from Captain G. Geddes last year, has, during the present year, been put into a complete state of arrangement by Captain Geddes. Special acknowledgment is due, in this connection, to Mr. James Fletcher, for his services in checking over and verifying the nomenclature of the entire collection, an operation requiring much labour and time. An important addition has been made to the Museum by the purchase of the ethnological collection of Mr. François Mercier, a collection of representative character, gathered by him in the course of a number of years' residence on the Yukon River. The Museum now contains a good typical collection of the arts and manufactures of the tribes of the west coast, from Vancouver Island to the Arctic Ocean.

The title of the detailed report of the Survey has, in the last issue, been changed from that of "Report of Progress" to "Annual Report," and this issue has been made the first volume of a new series which it is intended to continue in the same form. A certain number of copies of each local report has been printed separately, and, though involving more labor in regard to distribution, and some additional expense, the plan has already proved to have many advantages, particularly in enabling the public to obtain, at a nominal cost, the information respecting any particular district.

The requirements of the Survey, in respect to increased museum and office accommodation, become each year more pressing, and the cramped condition and limited accommodation afforded by the building at present occupied is now such as, in some instances, to seriously embarrass the work in progress. It is respectfully submitted that an office of such capacity is required as would enable the apportioning of a separate room to each officer entrusted with the work in a particular district, while the museum building should have a character more proportionate to the value of the collections, and more creditable to the Dominion. Several plans have been suggested by which the requisite additional accommodation could be secured at a comparatively small outlay, and I venture to hope that the matter will shortly receive the favorable consideration of the Government.

In British Columbia the exploration of the most important area of the Cariboo gold-bearing district was continued by Mr. A. Bowman, the Government of British Columbia contributing, as before, towards the expense of this work, which involves the mapping of a very rough district, in addition to its geological exploration. It is anticipated that a map and report on this district will be ready for

publication next spring. Mr. Bowman gives the following details respecting the work accomplished:—

"In continuation of the work of 1885 in Cariboo district, I left Victoria 23rd June, accompanied by Mr. James McEvoy as geographical assistant; procured pack, animals, supplies, and four additional men at the 150 Mile House, all in Cariboo district; and on Saturday, the 3rd July, started into the field.

"Our equipment this year was suited to exploration in the mountainous parts, away from the waggon road and trails ordinarily travelled.

"The field covered was, in general, the same as last year, the mining region embraced between latitude 52° 40′ and 53° 40′ N., and longitude 121° to 122° W., but the work differed somewhat in character, as well as in method of execution. Last year the roads and trails were measured; a waggon was used as a base of supplies in connection with three or four pack animals; the centrally situated mountains were occupied as triangulation stations, and geological and mining features were subordinated to geography. This year I was able to entrust most of the geographical work to Mr. McEvoy. Although our parties were equipped to move independently of each other we generally worked together, or near each other, and my attention to the geographical work was only directed to its general progress and final completion in connection with my own investigations. From this would be excepted, however, those parts of the country visited exclusively by my party, and all the details of the geological work to be fitted into the map.

"The Goose Creek mountains, and the Selkirk range, where there are no trails, were traversed with shoulder packs, relying on the rifle, to a considerable extent, for supplies. A micrometer measurement of the great Quesnel Lake was carried out with the aid of a large Chinese boat and an Indian canoe. Bear and Swamp River mountains and the Dragon Creek mountains were ascended with a single pack horse, relying on the axe for progress in lieu of a trail.

"The geographical work was completed by occupying with the transit all the necessary outlying stations, and by measuring with the steel tape two independent base lines approximately fifty miles apart, situated respectively on Snowshoe Plateau and at Quesnel Mouth, which will be used as the foundation of the whole of the work.

"In the geological work pursued by myself while thus completing our map, it was the distribution of the rocks and the mining features of the country that governed, not only my own movement, but the movements of both parties. A section was made from the limestone rocks of Beaver Lake, through the gold bearing series, to the northern Selkirk or Inner Cariboo watershed, between Mitchell's Lake and Canoe River, near Albreda Lake. Subsequently the cherty rocks of Bear River, which occupy a prominent position in Cariboo, were intersected at various points, and in different directions. Quartz ledges, adjacent to the rich placers heretofore mined, were everywhere noted, examined, and sampled for assay.

"As results of the season's work, I may mention the discovery of abundant evidence of the continuousness, permanence and richness of quartz ledges of Cariboo, and of fossils in the gold bearing region, which determine its age and position in the geological scale.

"The slates are of palæozoic age, and not improbably identical with those of Anderson River and Boston Bar, on the lower Frazer, associated with the first gold mining in British Columbia, accordingly much older than the auriferous rocks in California, as determined. On the other hand I found near Quesnel Forks very good placer diggings, the gold of which is derived from rocks containing fossils of the 'Shasta Group' of the Cretaceous.

"The time occupied in field work was from June 23rd to November 6th, four and a half months."

Cost of field work, $3,733.45.

In 1885 Mr. R. G. McConnell had been occupied in geologically exploring the Rocky Mountains to the north of the line of the Canadian Pacific railway, and it became obvious as the result of this work and that carried on by Dr. Dawson in other parts of the mountains, that a carefully examined section across the entire width of

the range at some chosen part was necessary as a clue to its intricate structure. Mr. McConnell, who was instructed to undertake the examination, reports as follows on it :—

"The principal object of the season's work was to obtain a more detailed section across the main Rocky Mountain range than the hasty exploratory work heretofore done has afforded; as it was considered that the knowledge thus obtained would greatly facilitate operations in more remote regions where the shortness and uncertain character of the season, combined with the difficulties in travelling, due to trails encumbered with wind-fall and crossed every few miles by swift mountain streams, which even near their source are often well-nigh impassable, render the prosecution of geological work both tedious and expensive. The country in the vicinity of the Canadian Pacific Railway was selected as the best adapted to the purpose in view, as, to its greater accessibility, it adds the further advantage of being more accurately surveyed than any other part of the range. Work was commenced on the 24th of May, at the Gap of the Bow, and during the course of the summer all the subordinate ranges lying between that point and Golden City were ascended and examined; involving altogether climbing to the extent of over 200,000 feet. In October the weather having become too severe for further work in the mountains a short time was devoted to the examination of the Cretaceous rocks of the eastern foot-hills in the vicinity of the Bow River. In addition to the stratigraphical work accomplished, a number of sketches and cross bearings were taken from the summits of most of the mountains ascended, which will add considerably to our knowledge of the topography of the region, and a large suite of fossils was collected from the various formations represented in the range. The results of the exploration have not been worked up yet, and cannot therefore be given in detail, but the following general statements may not be uninteresting.

"The Rocky Mountains are mainly composed of strata ranging in age from Middle Cambrian to Lower Carboniferous. Along the line examined this series has a minimum thickness of 20,000 feet, and is apparently conformable throughout, although in other parts of the range distinct unconformities have been detected both by Dr. Dawson and Dr. Hector, and that deposition was not continuous throughout the entire period is shown by the fact that in the eastern part of the range the Silurian is scarcely represented, although it becomes of considerable importance on approaching the Columbia. East of the main divide the Lower Carboniferous is overlaid in places by beds of Lower Cretaceous age, and here again, although the two formations differ so widely in respect to age, one overlies the other without any perceptible break, and the separation of one from the other is rendered more difficult by the fact that the upper beds of the Carboniferous are lithologically almost precisely similar to those of the Cretaceous. Were it not for fossil evidence, one would naturally suppose that a single formation was being dealt with. This great series of conformable strata shows that prior to the last great upheaval which gave the range its present form, the region was subjected to little disturbance and no folding or crumpling of the rocks to any appreciable extent had been produced. This fact is also further evidenced by the prevalence of one dominant type of structure. From the axis of the range to the eastern edge, the beds nearly everywhere dip regularly and usually at high angles in towards the centre. This uniformity in dip is produced by a series of great fractures accompanied by displacements of many thousands of feet which have had the effect of causing the same beds to be repeated at least seven times. These faults are of great length and run in approximately parallel lines, and as soon as or before one dies out it is replaced by another a few miles distant which continues on in nearly the same direction. The range is bounded on the east by a dislocation of such magnitude that few occurrences of a similar character elsewhere can bear comparison with it, and which has affected all the formations intervening between the Upper Cambrian and Middle Cretaceous. The Cambrian limestones have been thrust forward for miles along the line of this fault and now overlie in a nearly horizontal position the black shales of the Cretaceous. West of the axis, only one fault has been clearly made out, but the beds have been so disturbed and altered by an intrusion of igneous rock near the line of section that the structure there becomes more

difficult to unravel. All the evidence collected, however, goes to show that west of the axis over-turned folds and not faults play the most important part. An interesting feature of this range and one which places it in rather an anomalous position among mountain chains is the fact that along the watershed range, and for several miles on either side of it, the beds, although folded to some extent, are less disturbed than in any other part, and in no place examined has denudation yet uncovered a granitic axis.

"In this region no mining of any importance has been attempted during the past season, with the exception of that done at Ottertail Creek, but prospecting has been actively engaged in, and a number of more or less important mineral deposits have been discovered. It may be worth while mentioning in this connection that the Cambrian and Cambro-Silurian limestone and schists which cover most of the country between Silver City and the Columbia, are almost everywhere metalliferous, and few mountains have been prospected in this district which have not yielded ores of some kind.

"In the Ottertail district the Ottertail Gold and Silver Mining Company have worked three claims during the season. One of these the "Louis" claim, is situated directly under the railway track, about one and a quarter miles east of the Ottertail station; the other two are on the east side of the creek, about a mile and a half up the stream from the railroad crossing. A good road has been constructed from the railroad to the mines and ample preparations made for effectively handling the ore. A little farther up the Ottertail is joined from the south by the Wetfeet Creek on which is situated the "Copper Bonanza," one of the best veins in the district. A large number of other claims have been staked out, one company alone owning over twenty within a circuit of a few miles, but with the exception of those mentioned above none are being worked at present. The uncertain state of the mining laws and the extra expense and trouble necessitated by having to register both with the Dominion and British Columbia governments, is largely responsible for this state of affairs. The ore in this locality is an argentiferous galena associated with some copper, zinc and traces of gold, and occurs in small quartz or calcite veins, running parallel or nearly so to the strike of the calcareous schists, shales and limestones, which form the country rock of the district. The veins are small, seldom exceeding eighteen inches in thickness, but are reported to contain a high percentage of silver. A stamp-mile has been put up near the C. P. R. crossing of the Ottertail by the "Rocky Mountains' Mining and Ore Reduction Company," and the ore from the different mines is now crushed and concentrated before shipment.

"Near Field Messrs. Coffman & Weitman have opened up the "Monarch" and "Cornucopia" claims in Mount Stephen, and the former especially now presents a very favorable appearance, showing over six feet of solid galena. The ore there is deposited in what miners call a "blanket-lode," and appears to impregnate a zone of interbedded calcareous rocks. It has been traced along the face of the mountain for several hundred yards, and since I was there Mr. Pattee, of Carleton Place, by blasting out a trail around an almost vertical cliff, has been enabled to explore it still farther and reports the discovery of a deposit nine feet thick. The galena is low-grade in silver, containing only from 4 to 11 oz. to the ton (See assays 19-22, part M. Annual Report of the Geological Survey for 1885), but possesses compensating advantages in the extent of the deposit, the easy and comparatively inexpensive manner in which it can be worked, and in its proximity to a railway station.

"A vein of calcite flecked through with grains of cinnabar is being opened near Golden City, and is interesting as being the only deposit of the kind known in the entire region."

Cost of exploration $1,094.17.

Mr. J. B Tyrrell, assisted by Mr. D. B. Dowling, was occupied during the entire summer in completing the geological exploration and examination of the country between the Bow and the North Saskatchewan River, east of the 115th meridian. A report and map of this district will be prepared during the present winter. Mr. Tyrrell furnishes the following summary of the work accomplished:—

"Accompanied by Mr. D. B. Dowling, I left Ottawa on the 10th of May and

proceeded at once to Calgary where our horses had been left in the autumn of 1885. Having there obtained men and the necessary supplies, we started eastward to the Lord Lorne Crossing of the Red Deer River where our survey began.

"Following the trail which Lord Lorne had marked out in the summer of 1881, we crossed Bull Pound and Berry Creeks and traversing a stretch of flat 'alkaline' country reached Sounding Creek. We there left the trail and followed the creek in its winding course for one hundred and twenty miles till it reaches Sounding Lake, lying in the middle of the Neutral Hills. Leaving this lake and crossing the hills in a westerly direction we reached Nose Creek, which we followed northward to its confluence with the Battle River, a little above the crossing of the Fort Pitt and Sounding Lake trail. The next few weeks were spent in examining the valleys through which streams run down into Battle River from the north, working from east to west in order to be able to reach Edmonton about the middle of July.

"During this time we were able to define with a fair degree of accuracy the northern extension of the low anticlinals, which had already been noted by Mr. McConnel in the region to the south, as bringing the sandstones and clays of the Belly River series to the surface from under the shales of the Pierre group.

"At Edmonton I secured a boat and in it made a traverse of the Saskatchewan as far east as Fort Pitt, while Mr. Dowling went round by the north trail with the horses and waggons, at the same time making an odometer survey of the line of travel and as much of the surrounding country as the time at his disposal would permit. Turning west from Fort Pitt we followed in succession the Vermillion River, and other streams flowing north into the Saskatchewan, till we again reach Edmonton, thus completing our preliminary examination of the district lying south of the North Saskatchewan and between the fourth principal meridian and the Edmonton-Calgary trail.

"Our attention was then turned to the country lying to the west of this trail. We proceeded overland to Rock Mountain House where we constructed a boat, and sending the teams back as they had come, I descended the river to Edmonton, making a geological examination of its banks, and a track-survey of those parts which had not yet been surveyed. Afterwards we went south-west to Pigeon Lake, made an examination of Battle Lake and the upper portion of Battle River, thence went west to Gull and Buck Lakes, the Blind Man, Medicine and Wolf Rivers, returning to Calgary on the eighteenth of November, when our horses were sent out to be herded and our outfit left in store for the winter.

"During the course of the season special attention was paid to the occurrence of the different coal seams throughout the district, they having been found to underlie a very much larger extent of country than could have been thought at all probable.

"The 'Big Coal Seam' on the Saskatchewan, for instance, was found to be on the continuation of a coal horizon stretching north-westward from Knee Hill Creek and the Red Deer River, underlying country which is at present completely grass-covered, and shows no external evidence of coal anywhere in the vicinity. Along the above mentioned river this seam has been burned in a number of places, and the ashes which were collected at the foot of the bank have been assayed by Prof. Chapman, of Toronto, who finds that they contain small quantities of both gold and silver.

"Besides matters of strictly geological interest, the character of the different soils have been noted, as well as the amount and character of the grass or timber growing thereon, so that it will now be possible to bring out a map showing the limits of the prairie and wooded countries, with notes on the nature of the underlying soil. Careful barometric readings have also been taken at numerous points throughout the area examined, in order to lay down on this map contour lines, sufficiently close to show at least the general slopes of the country.

"A number of fossil remains, both of plants and animals, were collected during the season, while Mr. Dowling devoted time to the collection and preservation of objects of natural history, of which mention is made on a succeeding page."

During the season forty-three photographs were taken, illustrating the character of the country. Field work ended on the 18th November, when the party reached Calgary.

Expenditure, $2,604.15.

Mr. A. C. Lawson, assisted by Mr. W. H. Smith, was engaged in the geological survey of the country to the east of the Lake of the Woods, the work being devoted principally to the mapping of the sheet which includes Rainy Lake and its vicinity, but covering also portions of adjacent territory and certain connecting lines which were found necessary in order to complete the geological and topographical information.

Mr. Lawson left Ottawa for field work on the 15th of June and returned from the field on the 12th of October. As the work of another season will be required to complete the information for the Rainy Lake sheet, Mr. Lawson has prepared a synopsis of the geological results so far arrived at in some detail, as follows:—

"The season's operations were begun at Wabigoon, where Mr. Smith was instructed to carry through a micrometer and compass survey from a fixed point on the Canadian Pacific Railway to Rainy Lake by way of the Manitou canoe route to connect with the system of township surveys on the Rainy River. The west side of the lakes on this route was mapped in detail as far as the middle of Manitou Lake, from which point onwards both points were embraced in the survey, being within the limits of the Rainy Lake sheet. Several weeks were next occupied by Mr. Smith in completing the survey of the north-western expanse of Rainy Lake from Couchiching northward to the Devil's Falls. In addition to the usual micrometer and compass survey, a transit line was run between the two latter points, as a basis upon which to check the variation of the compass, which does not appear to be uniform throughout the district. This done, Mr. Smith next made a survey of an important chain of lakes extending from the bottom of Redgut Bay, Rainy Lake, to Lake Manitou, which it is believed has never hitherto been explored. During the last few weeks of the season Mr. Smith was engaged in completing certain detached surveys near the mouth of the Rainy River and in the south part of the Lake of the Woods, which stress of weather or other adverse circumstances had interfered with the previous season; so that nearly all the topographical material requisite for the mapping of the Rainy River sheet is now on hand.

"After having at the beginning of the season provided Mr. Smith with men and equipment requisite for his survey of the Manitou route, I left him at Wabigoon and proceeded to Rat Portage. Here two or three days were spent in the usual preliminary arrangements, and in inquiring into the state of the mining industry of the district, after which I proceeded to make a topographical and geological survey of the canoe route which extends from Lake of the Woods to Rainy Lake *vid* Crow Lake and Pipestone Lake. The route consists of a chain of large lakes which have never hitherto been mapped. The west side of the Crow Lake had previously been traversed by the survey, so that work was begun in the neighborhood of Turtle Portage, and carried along the south side of Crow Lake, thence through Boulders, Sand-hill and Schist Lakes into Pipestone Lake, and then through Stonedam, Loon, Jackfish and Footprint Lakes to the north-west bay of Rainy Lake. The survey was made by means of a Massey's patent log, the portages being chained, and was checked at various points on previous surveys. The Keewatin (Huronian) rocks of the Lake of the Woods were traced out eastward and southward of Crow Lake, and were found to have an extensive development in those directions to a point midway between that Lake and Rainy Lake; and as the same rocks are found along the Manitou route, it would appear probable that they occupy the intermediate country between the two routes, although that is a point which has yet to be investigated. On Stonedam Lake the Keewatin rocks give way to granitoid gneisses. The gneisses continue through to Rainy Lake, and it was here observed that they exhibited a more decided tendency towards a differentiation than has hitherto been noticed throughout the region. The two types into which the gneiss here resolved itself are a rather massive syenite gneiss and a more distinctly laminated biotite-

gneiss. An attempt was made to trace out this differentiation, not only on the Pipestone route, but also on the western shores of Rainy Lake, by subjecting them to a more critical examination than had been given them at the time of their topographical survey during the previous season. This attempt met with some measure of success, and it was found that throughout the field there can be distinguished as regards mineralogical composition :—

1. (*a*) Hornblende syenite gneiss
   (*b*) Mica syenite gneiss. } With little or no quartz.
2. Quartzose biotite gneiss.

"Both of these vary much in their texture, from coarse grained granitoid to regularly foliated gneisses. Often they are marked off from each other very distinctly, and when this is the case the syenitic gneiss appears to occur between the quartzose biotite gneiss and the lowest member of the green schists of the Keewatin (Huronian) series. At other times the quartzose biotite gneiss and the syenitic gneiss so confusedly intermixed that it is a hopeless task to attempt to separate them. Whether these two types of gneiss can be sufficiently separated to permit of a geological generalization which would be of service in the elucidation of this great fundamental series of rocks can only be ascertained after the field notes have been carefully plotted. The belt of Keewatin rocks which crosses the Kishcotena route between Lake Kishcotena and Lake Despair was studied in detail and traced in continuous connection with the area of the same rocks examined earlier in the summer on Crow Lake and Pipestone Lake. Some three or four lakes, of which Kaktimisagamak Lake is the most important, were surveyed, and added to the topography of this route. The geological features of the northern part of the Manitou route were mapped by the aid of the topographical sheets supplied by Mr. Smith's survey. The section proved an extremely interesting one, revealing, among other things, an extensive fault, with which is probably associated the origin of the long, narrow, deep body of water known as Lake Manitou.

I returned to Rainy Lake by the Little Canoe route, making a log survey of the several lakes which forms it, and mapping the geological features exposed on their shores. These four approximately parallel routes, the Kishcotena, the Pipestone, the Manitou and the Little Canoe, together with the two others, the Little Gull Lake route and the Big Canoe River, which have yet to be surveyed and examined, afford as many parallel sections across country by the aid of which, since they are all more or less interlacing, it is hoped that the distribution of the different formations in this part of the field will be satisfactorily mapped.

"In the southern part of Rainy Lake some time was spent in working out the geological features of the islands and part of the south shore, as well as of those portions of the north shore which required special investigation in the light of the previous season's work; and considerable additions were made to the topography. The most interesting fact brought to light is that, whereas on the Lake of the Woods and in the northern part of the Rainy Lake district the hornblende schists and the altered traps which constitute the base of the volcanic division of the Keewatin series are generally (though not always) in immediate contact with the granitoid gneisses, here there occurs between the green schists and altered traps, and the fundamental gneiss, an immense development of mica-schists with some fine-grained, evenly-laminated, micaceous gneiss. The underlying granitoid gneiss bears the same intrusive relation to these mica-schists as it does to the basal hornblende-schists of the Lake of the Woods. The formation appears to thin out towards the north and to expand in volume to the south into Minnesota. It constitutes the floor upon which the present green schists and altered traps have been deposited, and its intervention between the latter and the granitoid gneiss, to a thickness of between two and three miles or even more, is a striking and conclusive argument, so far as regards this region at least, against the theory which would make lithological character a function of age, and therefore an indication of the relative ages of the non-fossiliferous rocks.

"For the purpose of acquiring a knowledge of the geological features of the south-eastward continuation of the Rainy Lake formations, and at the same time of

becoming familiar in a general way with the features of the country between Rainy Lake and Thunder Bay, the last few weeks of the season were devoted to an examination of the shore of the canoe route along the Canadian side of the Minnesota boundary, and the field work was brought to a close at Port Arthur."

Expenditure in connection with work, $1,387.36.

Mr. A. P. Low, accompanied by Mr. J. M. Macoun as assistant, left Ottawa on the 10th of May, and proceed to Selkirk, to await the departure of the first boat for the mouth of the Berens River, on Lake Winnipeg. This point was reached on the 28th of May.

Here, having purchased canoes, the season's work was commenced, and a micrometer survey was carried up the Berens River to the height of land, between the waters of Lake Winnipeg and those falling direct into Hudson Bay.

This point was reached on the 17th of June, the distance along the route surveyed being 168 miles. From its mouth the Berens River trends a few degrees south of east for 102 miles to Family Lake. Throughout this distance its course is broken by numerous small falls, entailing many short portages.

At Family Lake the river bends sharply to the north, and the survey line runs in a slightly north of east direction to the height of land, and passes through several small lakes in that distance.

The watershed was passed by a short portage, ending at two small lakes on a small stream at the head of the middle branch of the Severn River.

Following this stream in a north-east course, and on the way passing through several little lakes surrounded by broken, rocky and barren country, the party reached Deer Lake on the 19th of June. This lake is distant 22 miles from the height of land, and is very long and narrow, with several deep bays. Here the track survey which had been made by Mr. Cochrane in 1882 ended, and, having been unable to obtain an Indian guide beyond this point, much trouble was experienced in finding and following the river running out of the lake. Descending the outlet for 175 miles, another large lake was reached, the shores of which were covered with a fair growth of timber, and the soil in the vicinity of which appeared suitable for cultivation. This is called Favorable Lake.

Following the river running out of it for 100 miles, a larger lake, called Sandy Lake, was entered. The country along the river was flat, and if not too swampy would make good farming land.

From Sandy to Severn Lake the distance is 150 miles by the river, which runs through moderately good country. Here an Indian was met who acted as guide to the Hudson Bay Company's post on Trout Lake, distant 55 miles, the intervening country being flat and swampy, with a small growth of black spruce and tamarac. Mr. Low was informed at Trout Lake that summer frosts were rare, and never damaged the crops of potatoes and roots grown there. No attempt has been made to grow grain. Leaving Trout Lake the survey was carried down the Fawn River, the outlet of the lake, which falls into the Severn River 226 miles from the lake and sixty miles from Fort Severn, at its mouth, which place was reached on the 6th of August, thus completing a line of micrometer survey from Lake Winnipeg to Hudson Bay, 582 miles long.

From Severn the party proceeded along the coast to York Factory. The shore between these points is very low and sandy, covered with a scant growth of grass and moss, the tree line being distant several miles from the sea.

The return journey was made from York in a small boat, by ascending the Hayes River route to Norway House, and thence down Lake Winnipeg, reaching Ottawa the 19th of October.

From Lake Winnipeg to Deer Lake the country passed through is rough and rocky, covered with a small growth of black spruce, aspen, poplar, banksian pine, tamarac and white birch.

From Deer Lake to Severn Lake the surface is much more even and the soil and timber better, the latter consisting of white, black and balsam spruce, aspen and

balsam poplar, tamarac and birch, many trees exceeding eighteen inches in diameter three feet from the ground. This section of the country is fit for agricultural occupation, but great difficulty will be experienced in obtaining an outlet until a railway is built.

Between Severn and Trout Lakes, and for 100 miles down the Fawn River, the country is very flat and swampy, the timber being chiefly black spruce and tamarac of small size.

Beyond this, as far as the sea, the river cuts more deeply into the surface of the country, forming a valley the banks of which are composed of sand and clay, and varying in elevation from 50 to 300 feet. Beyond the valley the soil appears light and poor, and in many places swampy, sustaining a small growth of black spruce and poplar. The rocks met with are all Laurentian as far as Favorable Lake. Here and along the route to Trout Lake, several bands of Huronian rocks are seen together with the Laurentian. These bands are highly magnetic and contain large quantities of pyrite.

Expenditure in connection with field work, about $3,600.

Dr. Bell was requested as early as possible in the season to visit the Grand Manitoulin Island with a view to examine and, if found necessary, correct the topographical and geological lines that had been laid down to be engraved for publication on the sheet map No. 126, on a scale of a quarter of an inch to a mile, and which had been prepared from the surveys made some years previously and would therefore, it was considered, probably require corrections and additions before being republished. Later in the season Dr. Bell was to explore a portion of the region lying to the South of Hudson's Bay and west of the District of Keewatin.

On this work Dr. Bell reports as follows:—

"In pursuance of these instruction I left Ottawa on the 12th of June and spent a short time on Manitoulin Island, where, being favored by fine weather, I got over a good deal of ground, but it was not found necessary to make any material change in the geological lines as they had been laid down. Two days were spent at Sault Ste. Marie where I hired six voyageurs for my northern exploration. On arriving a day later at Port Arthur, these men were sent on immediately with Mr. John McMillan and Mr. Alfred P. Murray, who were to act as my assistants, to Wabigoon tank, on the Canadian Pacific railway, which was selected as our starting point. Provisions and other supplies were purchased at Port Arthur the same day and forwarded to Wabigoon tank. I had ascertained by correspondence that it would be difficult to obtain bark canoes, which are almost essential for the kind of work which lay before us. In the course of a few days, however, I succeeded in obtaining four canoes large enough for carrying my party and all the supplies we required for the whole season. Smaller canoes were afterwards obtained from time to time as required.

"Before we could start on our canoe voyage everything required to be transported over a 'tote road' from Wabigoon tank, a distance of eight miles, to Sandy Lake. Leaving this long portage on the 6th of July the general course of my route was north-eastward, or towards Cape Henrietta Maria on Hudson's Bay.

From Sandy Lake I proceeded to Lonely Lake by way of Minnetakie Lake and its outlet. My route then lay through Osnaburgh Lake (or Lake St. Joseph) and the upper part of the Albany River, from which I crossed the country northward to the Attawapishkat River and descended this stream to the sea. Coasting southward on the west side of James' Bay, the Albany River was reached and ascended to The Forks, or junction of the Kenogamin River. Following this stream to its source we passed through Long Lake and descended the Black River to its intersection with the Canadian Pacific railway.

"Exploratory or track surveys were made of the route followed from the time we entered Long Lake till I reached The Forks of the Albany River, with the exception of the coast of James' Bay between the mouths of the Attawapishkat and Albany Rivers. In making these approximate surveys, the distances were ascertained by a boat's log or by the time occupied in traversing them at a known speed, while the bearings were taken by compass. Observations for latitude were made almost every day, and the variation of the compass was also frequently ascertained,

so that I have the means of checking my positions as given by the above method. Careful sketches were always made of the shores of lakes and rivers, the positions of islands, points, &c., being checked by frequent bearings. The total length of the exploratory surveys made during the season by myself and assistants cannot be stated until the work shall have been plotted. In the course of my journey upwards of forty photographs were taken, which show the character of the natives, the scenery and the surface geology of the country traversed.

"From the above general sketch of my route and of the method employed, the following brief account of the work done will be the better understood. In passing through the eastern part of Lonely Lake a track survey was made of our route as an addition to the approximate survey of this part of the lake made by myself in 1883; and from the head of Lonely Lake (simultaneously with the geological examination of the country) surveys of the same kind were continued as above stated. Leaving the eastern extremity of Lonely Lake we ascended the small river which flows into it, and turning up one of its eastern branches we reached the height of land near Osnaburgh Lake.

"In passing through Osnaburgh Lake we explored its principal bays and then descended the Albany to the outlet of Eabamet (or Labamet) Lake, on the north side. It was here that we turned northward and followed up a chain of lakes, discharging by small rapid streams from one into another until we gained the height of land separating these waters from those of the Attawapishkat River. From the head of this chain of lakes it had been our intention to follow a small river, which was reported to flow northward into a lake on the Attawapishkat River, but not succeeding in finding it we descended a rapid stream with many portages, which followed a north easterly course to its junction with this river. Two days before I reached the Attawapishkat, Messrs. Macmillian and Murray with two men were sent back to do other work which will be referred to further on.

"On arriving at the Attawapishkat I left my stores and large canoe in charge of one man on an island at the junction of the rivers, and which I called Nolin's Island, and proceeded with the other men to examine the upward course of the larger stream for some distance previous to descending it to the sea. At about eleven miles above Nolin's Island we reached the lowermost lake of the Attawapishkat, which the Indians informed me bears the same name as the river itself. It lies diagonally across the course of the river, and has a length of about nine miles from south-west to north-east by four miles from south-east to north-west. Two miles above Attawapishkat Lake we entered a beautiful lake of much larger size, which having as yet no distinctive name I propose to call Lake Lansdowne, in honor of the Governor General of the Dominion. This lake proved to measure about thirteen miles from south-east to north-west by about ten miles from south-west to north-east, and it is the largest sheet of water connected with the river. It contains many large islands and is much indented with bays. The surrounding country is more or less undulating and hilly, and thus affords a pleasing contrast to the level and monotonous character of nearly all the rest of the region explored during the season. The commencement of the upward continuation of the Attawapishkat River is found in the south-western bay of Lake Lansdowne. This part of the river is described by the Indians as being broad, having, for the most part, a sluggish current and expanding occasionally into small lakes.

"The Attawapishkat River proved to be somewhat smaller than the Albany which is not far from the size of the Ottawa above the capital. It descends at an almost uniform rate all the way from Lake Lansdowne to the sea, a distance of several hundreds of miles, notwithstanding the fact that in the upper part of its course it traverses Laurentian and Huronian rocks, while the lower portion flows over unaltered flat-lying limestones. In this distance we did not require to make a single portage and from the description of the river above the lake, it would appear to be navigable without portages almost to its source, which has probably an elevation of more than 1,000 feet above the sea. Where it flows over the limestone country it is broader and shallower than in the higher parts of its course.

"Along the upper part of the river the banks were lower than further down,

where the spring freshets fill up the bed of the stream to a height of from twenty to thirty feet, and even more, above the summer level, and the ice which comes down at these times has swept the banks clear of all obstructions and given them an uniform appearance throughout, except where cliffs and islands of limestone occur.

"The shores and islands of Lake Lansdowne are well wooded with large spruce, tamarac, aspen and rough-bark poplar, with fair sized cedar and white birch; and the same kinds of wood continue along the banks of the river for many miles down, but the timber at a distance from the water is of smaller size. In the low, level country, not only along the lower part of this river, but on the west side of James' Bay generally, the greater part of the area between the rivers appears to consist of open sphagnum plains, with some small spruce and tamarac trees, either in groves or scattered singly, while the immediate banks of the streams are well wooded. In places the better class of timber forms belts extending for some miles back from the rivers. The fossiliferous limestones of the west side of James' Bay extend for a considerable distance inland on the Attawapishkat River, but they can only be mapped when my approximate survey shall have been plotted. The sea coast between the Attawapishkat and Albany Rivers is very low and uniform in outline and without indentations. The water is so shallow that we could touch the bottom with our canoe paddles at from half-a-mile to one mile from the shore. In order to pass the bouldery reefs, which extend from the shore north of the Albany, we were obliged to go as far out from the land that the tops of the trees were barely visible at the highest places.

"A careful track-survey of the Albany was made from its mouth to The Forks, which, with that of the upper part also made during this season, when plotted, will enable me to map the whole course of this river, an actual survey of the intermediate portion having been made by myself in 1870. This river possesses additional importance from the fact of its constituting part of the northern boundary of the Province of Ontario.

"From the mouth to The Forks the river passes through a low and very level country, and it is characterized by a wide shallow bed with ice-swept banks like those of the Attawapishkat, but of somewhat greater height. On the Albany the limestones do not form conspicuous cliffs and islands as on the latter stream. The numerous large islands in the Albany form one of the features of the river between The Forks and the sea. My supposition, based on former explorations, that the Devonian limestones extend from James' Bay nearly, if not quite, to The Forks, has been confirmed by the present year's examinations.

"The Kenogamin River and Long Lake are described in my Reports for 1870 and 1871, but the Black River had not been previously examined geologically. The rocks in its valley were found to consist of crystalline schists and diorites, granite, syenite and gneiss.

"Before reaching the Attawapishkat River, as already stated, Messrs. Macmillan and Murray with two men were sent back to perform other duty. They were instructed to make a track survey between Eabanut Point and Abasotiketchewan Lake on the Albany, to the latter of which my instrumental survey of 1871 had extended. They were then to proceed to make a geological examination of Cat River from Osnaburgh Lake to Cat Lake and to return home by way of Wabigoon. On my return here I found they had accomplished the above work, with the exception of the upper third of the Cat River. By using the map laid down from micrometer survey by Mr. Thomas Fawcett, D.L.S. (for the use of which we are indebted to Surveyor-General Deville) along with the track-survey made by Mr. Macmillan in connection with his geological notes, a considerable addition is made to our knowledge of the distribution of the rocks in the region which he traversed."

Mr. E. D. Ingall left Ottawa for his field of work in the Thunder Bay District on the 9th of June, returning to Ottawa on the 13th November. He was assisted by Messrs. H. P. Brummell and J. H. Moore, and was engaged principally in continuing and completing his work previously carried out in connection with the Silver Mountain and Rabbit Mountain mining regions and adjacent territory. This work will be

made the subject of a detailed report, accompanied by a map, as soon as the results can be elaborated. Mr. Ingall has prepared the following sketch of the mining developments of the district, which embodies the main results arrived at, in advance of the detailed report:—

"The new mining region to which attention is now especially directed lies west south west from the town of Port Arthur on Thunder Bay, Lake Superior, which place is the headquarters of the mining men and explorers.

"The discoveries are situated along the northern fringe of a range of hills forming the southern boundary of the valleys of the Kaministiquia and Whitefish Rivers as far as the source of the latter, a distance of some 60 miles from Port Arthur.

"There are two chief centres of activity in this belt of country which is from four to six miles wide, namely, Rabbit Mountain and Silver Mountain. At these two places numerous mining locations have been taken up. On some of the most promising of these a fair amount of work has been done towards testing, whilst on the rest little or no developments have been made. In some cases it seems doubtful if the purchasers were ever in the country at all, for many locations are situate in valleys where the rock must lie under a very considerable thickness of clay or even of swamp soil.

"Besides the veins located around these two places a fair amount of exploration and acquirement of locations has gone on around Whitefish Lake in the same series of rocks, and a few have been located in their extension south of this, towards the international boundary at Pigeon River.

"The surface of the region consists of a number of flat-topped hills, frequently roughly circular, separated by valleys about 200 to 300 feet deep. From the tops of the hills down, the rock is shown in cliffs varying in height from 30 to 150 feet, below which the debris fallen from above slopes off at an angle of about 45° for probably another 50 feet when it merges into the gentler slope of the clay and soil filling the valley.

"Geologically the rocks in which the veins occur belong to the Animikie series, which is presumed to be Lower Cambrian. The strip of country containing the discoveries is from two to four miles away from and runs roughly parallel to the junction of these Animikie rocks with the granite rocks, and other rocks to the north referred to the Huronian.

"The Animikie rocks of the Silver Mountain district lie nearly horizontal and consists of diabase trap, black argillites and some ferruginous dolomites, chert and jasper. The diabase caps the tops of the hills and has a thickness of from 150 to 200 feet, but the hills being bevelled of all round the thickness of the rocks shown in the cliffs is only from 50 to 100 feet. Below this trap come about 200 feet of argillites, whilst at Silver Mountain below this again are to be seen about 100 feet of the chert and jaspery beds. The depth to which these latter extend cannot be ascertained as the soil of the valleys covers up everything below this.

"The trap occurs also as intrusive sheets, and although it is most probable that dykes of this rock occur I have not as yet been able to indentify any. If they do exist in the Silver Mountain area they must have weathered away more easily than the other rocks and for this reason are always covered up. The reverse of this is found to be the case in the section of these rocks shown along the coast of Lake Superior between Port Arthur and Pigeon River where the dykes form points and even protrude as distinct walls on passing inland from the shore.

"The argillites are in places soft and black, whilst at others they are harder and siliceous, and again at others contain a small proportion of magnetite.

"The lower siliceous beds consist of a variety of rocks, black, white and green cherts and jaspers, the latter often plentifully sprinkled with vermillion spots. Interstratified with these are irregular beds of dolomite, generally rusty colored from the presence of iron. These siliceous rocks all contain iron in varying amounts—sometimes as ferric oxide, sometimes as magnetic oxide; the latter occasionally forming such a large proportion of the rock as to constitute an iron ore. An analysis of a specimen of such ore gave Mr. Hoffmann 53 per cent. of metallic iron and no titanic acid.

"The principal veins of the *Rabbit Mountain* district are seen to cut through similar hills of black argillites, capped by the same kind of trap, but as I have only begun a detailed examination of this latter district I cannot yet say whether the section downwards is the same in detail as at Silver Mountain.

"To the north of Whitefish Lake and West of Silver Mountain is an area consisting chiefly of the siliceous group in which several veins have been discovered, whilst a few which have been located on the south side of the lake cut the argillite group.

"These lodes are true fissures, as evidenced by the way they have faulted the 'country' rock, the vertical displacement varying in different cases from a few feet up to 70 or 80 feet in one case. They vary in their size and definiteness in the different beds. In the trap they are generally wide and filled with a solid mass of gangue minerals, often having in the centre large cavities or 'vugs' lined with coarsely crystallised calcite, whilst in the argillites they are composite, breaking up into a number of branches and stringers distributed through the 'country rock,' or else they form a regular brecciated vein with the gangue minerals crystallised around the enclosed portions of the argillites. The veins which have been discovered in the lower cherty beds are generally more solid and with more definite walls than those in the argillites.

"At times great difficulty is experienced in following these veins in the argillites owing to the fact that in drifting or sinking they pass from a good solid vein to portions where it is all split up into numerous small stringers, distributed through a large thickness of 'country' rock, so that only one or two of them can be followed. This has sometimes led to the belief that the vein had 'pinched out,' and that the veins do not continue downwards. This is, however, an erroneous belief, for such very shallow fissures would hardly have produced the amount of displacement of the rocks so frequently found, and further, one would naturally expect such local splitting up and indefiniteness of the veins in such laminated rocks as these argillites. This idea is borne out by the appearance of the veins where they cut the upper trap. This being compact, they are there large and solid. I feel sure that where there is a vein showing evidence at other points of being a 'strong' one, if followed carefully through the distributed part, it will again come together and become solid, and this has been the case in more than one instance in the region.

"The gangue or veinstone in these lodes consists mostly of barite, calcite and fluorite (green and purple) with white and ameythistine quartz. The relative proportions of these minerals vary considerably in different parts of the vein. The silver occurs in the form of argentite and native. The former is the most common, the latter, so far, seeming to be confined to surface or to some slight depth below it. The other metallic minerals are pyrite, blende and galena. The two latter vary in the amount of silver they carry, sometimes assaying none, sometimes yielding a considerable percentage.

"It seems to be the rule, so far, that where the vein is charged with silver the blende and galena also carry it although it is not visible in them, whilst, away from these places, they are as a rule either poor in silver or wholly free from it.

"The veins usually have the silver concentrated in spots in them, these ore bodies being of greater or less extent and varying much in their richness, sometimes assaying even into the thousands of dollars per ton, sometimes bodies yielding $100 down to $10 or less per ton. Between the ore bodies are barren stretches of greater or less extent where the vein carries either a small proportion of blende, pyrite and galena or often no metallic mineral at all. At those places where they cut the upper trap bed the veins either carry no silver or very little.

"Although much exaggerated talk has been indulged in in the locality to which one cannot subscribe, the occurrence of rich silver ores in the veins is a fact.

"I have personally visited some eight different properties where I have seen excellent ore in the veins in bodies of greater or less extent. In some cases the quantity has been small but encouraging as an earnest of more extensive bodies yet to be discovered by underground development, whilst in others the extent of the ore has been such as to yield from $5,000 to $30,000 or perhaps more.

"The precious metal is not found all at one spot in the veins. In one instance I was recently present when some very rich ore was taken out which was full of argentite in the form of nuggets and sheet leaf, and 600 feet from this spot silver was recently found in another opening on the same vein.

"At another place equally rich ore was discovered at a depth of 160 feet, a body of rich ore having been previously taken from the outcrop of the vein, and mill rock is now being taken out at a depth of 40 feet.

"In yet another instance very rich ore was taken out of the vein at one place and, although this did not prove extensive, further development disclosed some good ore near the first body, though sufficient work has not yet been done to judge of its extent. On the same vein ore running about $200 to the ton has been found at a mile distant from the first discovery.

"The chief development work in the region has been made at the following points:—Silver Mountain East End, Silver Mountain West End and Crown Point in the Silver Mountain district, whilst in the Rabbit Mountain district the chief work has been done on the Rabbit Mountain, Beaver and Porcupine veins. At all of these points ore of greater or less richness and extent has been obtained. At Rabbit Mountain a mill is now erected to treat the ore with a daily capacity of 15 tons, which has been running since first August last, whilst at the Beaver mine a similar mill, but of larger capacity, is being built. None of the mines have as yet attained a depth below the overlying trap of more than 200 feet, and they are therefore all in the argillite. The reason of this is that nearly all the veins intersect hills or ridges some 200 feet high, and it has therefore been most natural to commence by driving tunnels into the sides of these hills.

"The opening up of the region has not been nearly so rapid as it ought to have been, owing to the many disadvantages under which it has labored, of which I propose to speak at length in my detailed report.

"For these reasons the district is not yet out of its trial stage nor will it be until there are a few mines opened up to a much greater extent than those at present existent, and we must anxiously await the confirming results of developments in depth. The question must be solved in several cases as to whether these ore bodies occur at sufficiently frequent intervals in the veins to pay for going through the intermediate stretches of poor ground, but I see no reason at present for supposing they do not.

"The region will of course have its failures as all mining districts have, where a great many of the veins found never develop into anything, but such does not prevent it from becoming an active mining region with many successful enterprises.

"Considering the difficulties under which prospectors labor and the comparatively small amount of prospecting and development done I think the results are very encouraging, and were the locality under more favorable conditions there would be ten times the amount of activity now observable. The development of the district requires not only energy, but the right direction of this energy, and the pursuance of a liberal policy both by the owners of mines and the Government controlling the land, the former when without the requisite means to develop the mines must not drive away the capitalist by counting on large sums for the mere right to work.

"Besides the possibilities of this section in the direction of silver mining there is a chance of its coming to the front as an iron producer, for the prevalence of magnetite and other forms of iron in the lower siliceous beds of the series raises the expectation that exploration may lead to the discovery of points where the iron ore occurs in sufficiently large and pure beds to be profitably worked.

"The attention of explorers has just now been turned to this question by the successful working of the iron deposits lately discovered at Vermilion Lake, in the United States Territory, which I recently visited, as mentioned above. These mines are situated in Minnesota and are about 120 miles west—south-west from Silver Mountain. Such has been the success attendant upon their opening that within the last two years the little town of Tower, with 2,000 inhabitants, has sprung up in the middle of the wilderness, and some 60 miles of first-class railroad, now operating,

connects it with the nearest shipping point on Lake Superior, and in about two months this railroad will be completed through to Duluth. At the present lake terminus of Two Harbours a little village has sprung up and there are complete docks for shipping the ore.

"The Company working the mines has nearly 1,150 men on its pay roll at present, and are shipping 1,100 tons of ore per day, worth about $5,700, or at the rate of about $1,700,000 per annum.

"There seems to be a prevalent opinion amongst the explorers and mining men of the district that the chances are good for the range of iron deposits to continue into Canadian territory. They run in that direction, and it is stated by some explorers that iron deposits have been found at intervals in a north-easterly direction from Tower as far as and even over the Canadian boundary. This point, however, requires further investigation.

"The ore at Tower is in the formation which is generally known in the region as the Huronian green slates, and as there are similar green slates in the Thunder Bay region the correctness of these statements seems probable. I have myself seen outcrops of similar though perhaps not quite identical iron ore deposits in this formation at other points on the Canadian shores of Lake Superior and at Kaministiquia station, on the Canadian Pacific Railway, the slates at which place may be the extension of the Vermilion Lake formation or of a parallel belt. Mr. Peter McKellar reports the discovery of a very large iron ore deposit near the Huronian Gold Mine, but this I have been unable to visit."

Expenditure in connection with field work $1,333.68.

Mr. E. Coste was engaged during the season of 1884 and the greater part of that of 1885, in the geological survey of sheet No. 113, Ontario, this sheet having been selected as that covering certain important mining districts. It includes parts of Hastings, Northumberland, Durham, Peterborough and Victoria counties.

The extremely untrustworthy character of much of the geographical and topographical information available for the part of the province in question, and the necessity of measuring and resurveying many lines in order to produce a map of sufficient accuracy for the proper delineation of the geological features, together with the geological complications which were discovered, continued to render the progress of this work much more tedious than had been anticipated. In view of these circumstances and the fact, which became evident in the course of the work, that the region immediately surrounding Madoc and Marmora required minute investigation and a very detailed survey, in order promptly to establish and explain the nature and relations of the deposits of iron ore and of the auriferous mispickel and quartz veins, with the granitic and dioritic igneous masses—a relation noticed by Mr. Coste in 1884—it was considered advisable to give this particular investigation the first place in the work of the present year. Mr. Coste reports that with the assistance of Mr. J. White as topographer, a map of the Madoc and Marmora region, including an area of about 700 square miles, has now been completed on a large scale. In addition to this work, about seven weeks were spent on portions of the northern part of sheet 113 outside this particular area. The complicated outline of the edge of the Cambro-Silurian limestones on the Archæan rocks had previously been mapped across the sheet by Mr. Coste, but with the purpose of endeavoring to separate the Trenton and Black River groups of the Cambro Silurian Mr. H. M. Ami was requested to make a palæontological examination of these rocks, which he successfully accomplished and at the same time obtained a number of interesting sections illustrating their character. Between six and seven hundred specimens of fossils were collected in this district by Mr. Ami. Mr. Coste states that the north-east part of sheet 113 has proved to be "of extreme geological complication. Fifteen large igneous masses and numerous smaller ones are to be found there in an area of about 500 square miles. They have cut the Archæan or primitive rocks to pieces and have completely metamorphosed large areas of the rock of that system, so much so, that I estimate these metamorphosed rocks (principally metamorphosed by injection) and the igneous

masses, to occupy about half the area of the Archæan of that part of the country. This great complication has made numerous traverses absolutely necessary in the parts examined, and though I have reason to think that these eruptions are less numerous to the west in the other parts of the map occupied by the Archæan rocks, it is nevertheless certain that there also many traverses will be required."

In consequence of these facts and the uncleared and sparsely settled character of the north-western part of sheet 113, it may probably be found advantageous to prepare this sheet with an accompanying report, for immediate publication, leaving the details of the intrusions probably yet to be discovered for future elaboration. Respecting the detailed map above referred to Mr. Coste writes as follows:

"Apart from the seven weeks already stated to have been spent by me this summer in the working out of sheet No. 113, the rest of my time, from the beginning of June until the middle of October was devoted to the detailed map of the Madoc and Marmora mining district, as well as the whole time, during that period, of my assistant, Mr. White, being engaged in the topographical work. I am pleased to report that we have been able to complete the work, and that we have now a map of 40 by 40 inches on the scale of 20 chains to an inch, showing with a great many details the geographical, topographical and geological features. A complete transit and chain re-survey of the whole area under examination had to be undertaken, and was well and diligently performed by Mr. White, assisted by two men. As the work proceeded Mr. White had to plot it in the field to allow me to put down accurately my geological lines, the old township maps available being of no service. Mr. White is now engaged in replotting and reducing the whole summer's work and the map to a scale of 40 chains to the inch. When geologically colored this map will clearly prove the close proximity I have referred to of the iron ores and auriferous quartz veins to the igneous masses and dykes cutting the Archæan, thus giving the key for further discoveries of economic importance in the Archæan rocks which cover so large an extent of country in Canada; besides being a guide for the district itself not only of what has been done towards the development of these mineral resources, but also of what may be expected and of where new work and researches should be directed. It will further show at a glance the very uneven and undulating surface of the Archæan rocks at the time the Cambro-Silurian sea invaded that country, and the great amount of valley erosion effected since the time the sea receded."

In December Mr. Coste spent about ten days in visiting some points in the province of Quebec from which additionl particulars were required for the purpose of completing information in regard to mineral statistics, and as the compilation and preparation for publication of these statistics for the current year will now be a first charge on his time, his detailed report on the Madoc and Marmora region may not be ready for publication for some months, though it is antictpated that it will form a portion of the next annual volume.

Mr. Coste's field work was begun the 21st May, and concluded on the 16th of October.

Expenditure $1,936.29.

Mr. R. W. Ells, in the following preliminary report his work in the Eastern Townships, has included a number of details bearing specially on the asbestos industry, which it seems important should be made immediately available.

"The work of the past season embraced the further examination of that portion of the Eastern Townships lying to the east of Lake Memphremagog, Richmond and Arthabaska, and extending thence to the Maine boundary, with the view of completing in greater detail the S.E. quarter of the map of the province of Quebec. For the purpose of better elucidating the somewhat complicated structure of this section over 2,000 miles of roads were carefully surveyed, the settlements of the last dozen years having opened up a large tract of country which had been almost entirely inaccessible to previous explorers, and enabling us the more readily to decipher and determine the outlines of the various geological formations. In this work I was ably assisted as in former years by Mr. N. J. Giroux.

"The latter part of the season was chiefly devoted to an examination of the principal mining areas, among which, from its great economic importance, special attention was directed to those localities where asbestos mining is now carried on.

"Highly important discoveries of graptolites at two points have necessarily led to a new and somewhat extensive re-arrangement of the several formations in the area in question, more particularly as regards the distribution of the Silurian (Upper Silurian) rock. Thus, by reference to the general map of 1866, it will be noticed that two very extensive areas of what were then regarded as of this age are depicted, the one extending northerly from the vicinity of Lake Memphremagog into the township of Ham, with a breadth of some twenty miles or more, while the second and of still larger area embraced the greater part of the country lying east of a line N.E. from Lennoxville and extending to the boundary of Maine. During the season of 1885, the necessity for correcting the boundaries of this system was noted, but no precise palæontological data could at that time be found which would fix the horizon of a great part of these rocks more definitely. In July last, however, while examining closely the country about Lake Memphremagog in company with Mr. H. M. Ami, considerable areas of black graptolitic slates on both sides of the lake were found to be very rich in organic remains (graptolites), &c., the exact age of which has not yet been ascertained, but which are very similar to many of those found at various points on the south side of the St. Lawrence, below Quebec, and which have been determined to be of Cambro-Silurian or Ordovician age.

"As regards the distribution of the Silurian (Upper Silurian) slates and limestones it has been found that these rocks are, for the most part, confined to limited areas and patches which have escaped denudation, and now rest unconformably upon great series of black slates and grey sandstones of presumed Cambro-Silurian age. These patches occur principally at Lakes Memphremagog and Massawippi, Stoke Centre and North Stoke, Lakes Aylmer and St. Francis, and the Chaudière River, between the Famine River and the village of St. George, Beauce. Fossils (corals, &c.) are found at many points throughout these rocks, which range from the Niagara to the base of the Devonian. Their unconformability upon the underlying slates is, however, well defined at several observed points. The relations of the crystalline schists and other associated rocks of the mineral bearing belt have also been again carefully studied by detailed surveys, and it is hoped that the additional facts which have been obtained during the past season will, when plotted, assist in satisfactorily establishing their true position as regards the graptolitic black slates with which they are intimately associated. This work will be done during the coming winter, when the final results will be duly presented.

"The various mountain masses, such as the Owl's Head, Orford, Ham and Bull Mountains, north-west of Lake St. Francis, all apparently belong to one era and form a disconnected chain of eruptive peaks which extend north-easterly for nearly 100 miles.* Their intrusive and eruptive character and comparatively recent age is clearly established by their action upon the black graptolitic slates which flank them and which are, in many cases, highly altered along the contact, the rock being in places changed to a true porcelain. Like these, also, they give off dykes into the surrounding slates and sandstones, with which are also intimately associated the great areas of serpentine, which have, during the last half-dozen years, come into marked prominence as being the country rock of the valuable mineral asbestos.

"The various mining industries carried on at several points are in some cases marked by a decided increase in the output of raw material. The new system of mining returns will, it is hoped, eventually furnish a great amount of valuable information, and it is highly gratifying to find, in all cases, such a willingness on the part of mining men to assist in every way the collection of mineral statistics.

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* This is the belt of rocks which I have elsewhere described and mapped as the Volcanic Group, or the upper division of the so-called "Altered Quebec Group;" at the same time I stated that these rocks might be of lower palæozoic (Cambrian) or of pre-palæozoic age. I cannot concur in the view above expressed that they are comparatively recent. They are certainly older than the Levis formation, while the black graptolitic slates on the south-eastern side of them are certainly newer.—A. R. C. S.

"The principal mining industries at present carried on in the section embraced in the season's work are:—

"The slate quarries of Rockland and Danville—the latter lately re-opened—while the former, by marked improvement in plant, is also rapidly increasing its output.

"The copper mines of Capelton, also showing a marked increase in output.

"The asbestos or crysotile mines of Thetford, Coleraine and Wolfestown, and the gold mines of Ditton and the Chaudière.

"As regards the latter industry, it is to be regretted that no returns can, apparently, be procured as to the amount of gold annually obtained from the Ditton gold field. The area being entirely in private hands, over which the Local Government has no control, no royalties are paid and no definite data can be had. There is no doubt, however, that a very large amount of gold has been found in this section and that the prospects for profitable workings are excellent.

"In the Beauce district work is being carried on in the Cumberland stream, a branch of the Famine, by Captain Richards; and on the St. André, near St. George, by the St. Onge Company. The returns from the former are very encouraging, but at the latter some further difficulty has been found in reaching the gravels of the old river channel, though gold is taken out in small quantity.

"The mining of asbestos is carried on at several points along the line of the Quebec Central Railway, viz., at Thetford, Black Lake, Coleraine and Belmina. Some work has also been done near Coleraine Station. Near Danville, four miles from the Grand Trunk Railway, a mine of considerable exten thas been operated for several years. As this industry has already grown to large proportions and bids fair to become one of the most important in the Dominion, a brief description of the various asbestos properties, its mode of occurrence, and some facts bearing on the future of the industry may be of general interest.

"The various companies engaged in mining asbestos at Thetford are King Bros., the Boston Asbestos Packing Co., Johnston & Co., and Ward Bros.; while at Black Lake and Coleraine are situated the mines of the Anglo-Canadian Co., Frechette's, and the Lionais Martin or Scottish Canadian Company's property. These all lie along or near the line of the Quebec Central railway, which crosses the property at Thetford, while at Black Lake it is from a quarter to half a mile distant from the workings. At Belmina, which is about four miles from the railway at Coleraine Station, a small force of men, from six to eight, have been engaged for several years merely on exploratory work, on property owned by Mr. John Bell, of London, England. With a view of acquiring more definite information concerning this valuable mineral a somewhat detailed examination of all these properties was made, in order to render assistance, if required, to any parties interested in this industry.

"All the asbestos mines in the Eastern Townships are situated on portions of the great serpentine belts which extend in tolerably direct lines, though with many breaks, north-eastward from the Vermont boundary for some distance beyond the Chaudière River. Further east these peculiar rocks present large areas in the Shickshock Mountain Range, which extends through the northern portion of the Gaspé Peninsula in rear of Ste. Anne des Monts, and further east on the lower part of the Dartmouth River. Though indications of asbestos are found at most points throughout the whole serpentine formation, the developments of this mineral appear, in so far as yet known, to be greatest in the areas about Thetford and Black Lake and near Danville, though there is no apparent reason why it should not be found in paying quantity at other points, and it is probable that subsequent exploration will largely extend the area where profitable mining operations can be carried on.

"The serpentines, without going into any detailed account of their mode of formation, may be stated to be intimately associated with masses of dioritic or doleritic rocks, of certain varieties of which, rich in olivine or some allied mineral, the serpentine is in many cases doubtless an alteration product. The serpentines are also frequently associated with masses and dykes of whitish rocks, often composed entirely of quartz and felspar, but at times with an admixture of black mica, forming a granitoid rock. They occur generally not far from the axes of certain anticilinals

which exist in the group of rocks designated the altered Quebec Group by Logan. (See foot note ante.) The asbestos traverses the serpentine in veins often irregular, and which range from mere threads to a thickness of three and even in some cases six inches, in all of which the fibre of the vein is, unless affected by the dislocation of the containing rock, at right angles to the sides of the fissure. The rock is in many cases somewhat impure from the admixture of grains or small irregular veins of chromic iron, which break the continuity of the fibre in the vein and require the mineral to be carefully "cobbed" in order to separate these impurities. The veins at or near the surface are also affected by the infiltration of water by which the asbestos is discolored and its value correspondingly reduced. This is especially noticeable in areas where the surface serpentine is shattered, either by the action of weather or other causes, and this discoloring ceases as the rock becomes solid. As a rule the veins increase in value or quality of fibre as lower depths are reached. Veins are not, however, continuous; the size frequently varies, and like all mineral veins they are affected by faults or slides which often cut off, completely, a valuable working face. In such cases the slicken-sided character is very marked; sheets of impure or imperfect asbestos with long coarse woody fibre lying along the lines of fault. The veins have often the aspect of true segregation veins, and the containing walls often change their character for a distance of half an inch to three inches on each side of the vein. The theory of their formation is, however, as yet an open question.

"Asbestos mining was commenced at Thetford in the year 1878, by what is now known as the Boston Asbestos Packing Company. The demand at that time was exceedingly limited and considerable difficulty was at first experienced in finding a market. The output for that year did not exceed 50 tons, but its value was soon ascertained, and explorations on the serpentine belt at this place resulted in finding asbestos in workable quantity over a considerable area.

"The Thetford River appears to mark the western limit of the serpentine on these properties, the rocks on the other side of the stream being altered slate and sandstones. To the east of the railway which cuts directly across the area the serpentine forms a knoll with an elevation of about 90 to 100 feet above the track. All the works are confined to this portion of the area and consists of open cuts in the face of the hill, nothing apparently having yet been done to ascertain the value of the area between the railway and the river.

"The quality of the asbestos at all the four mines at this place may be stated as excellent. The fibre is fine and readily worked, and the veins are, for the most part, especially in the lower cuts, comparatively free from chromic iron or other impurities, reaching a width of from three-quarters of an inch to four inches, though in some, notably the quarry of Johnston & Co, veins of five or six inches are observed. The fibre in these large veins are not, however, of such good quality, in so far as yet worked, as that found in those of less size, and veins of one and a half to three inches give as good material as can be wished. Numbers of such veins yielding fibre which ranks as extra first quality are found in all the mines at this place. In some of the cuts these appear as a perfect interlacing network in the surrounding walls, and can be counted by the dozen. While all these properties may be said to be about equally productive, that of the Boston Company may be especially mentioned both for the amount of its output, which will probably equal that of the three others combined, as well as for the excellent way in which the property has been developed by its experienced manager, Mr. Thomas Sheridan, with a view to successful future operations, and also as illustrating the remarkable improvement in the quality and increase in the quantity of the fibre as the depth increases; a feature clearly established at all the mines, not only in this vicinity, but also at Black Lake.

"The profitable output of the asbestos is at present apparently only limited by the demand. The amount extracted since the commencement of operations here may be briefly stated thus:—

"Boston Asbestos Packing Company, opened 1878, output for 1886, 700 tons. Total output to end of 1886, 30,000 tons.

"King Bros., for 1886, say 250 tons, adjoining to north, total since 1881, 850 tons.

"Irving-Johnson Company for 1886, say 400 tons, opened since 1879, total 2,500 tons.

"Ross-Ward Bros., one quarry, three years only, say 400 tons.

"The cost of extraction varies in different localities and depends upon the amount of barren rock encountered, which owing to the action of faults is greater in some cuts than others. It may, however, be safely put down at $20 to $25 per ton.

"The prices obtained for the asbestos at points of shipment on railways range from $50 to $55 per ton for second quality to $80 or even $100 for first, a considerable portion of that taken from the lower cuts realising the latter figures. The markets are Great Britain, Germany, Belgium, the United States and Italy.

"The majority of the veins worked range from three-fourths of an inch to two inches and a half. The material is blasted out, carried to the dump broken up and cobbed by boys and old men, who grade the asbestos, this latter depending upon the color as well as purity of the fibre, with due regard to its length. The wages paid for laborers in the quarry range from $1 to $1.10 per day, and for boys and cobbers, 50 cents.

"The comparison of the cost of extraction with the value of the raw material shows a very good margin for profit. The works at this place are, however, carried on, for the most part, during the six months of summer and autumn only, since it has not as yet been found advantageous, in view of the limited market, to undergo the inconvenience and extra expense of continuing operations during the winter. As the market enlarges, however, the mode of working will doubtless adjust itself to the demand. The properties worked at Black Lake are situated on the west side of a steep ridge of serpentine which rises to a height of about 900 feet above the waters of the lake itself. The three areas are contiguous and from a fourth to a half mile east of the railway. The work is carried on by open cuts in the face of the hill, in all of which veins of excellent asbestos are disclosed, ranging in size up to four inches. The fibre is, in most of these, somewhat discolored from the presence of water which penetrates the shattered serpentine, and, as a consequence, the greater portion of the output grades as second; but in most of the openings the solid rock is now reached, and the quality of the asbestos is rapidly improving. These mines have not been in operation so long a time as those of Thetford, but the output, which is as follows, shows readily the growing importance of this locality:

"The output of the Anglo-Canadian (formerly Hopper's mine) for 1886 may be stated at 550 tons, and total output for the four years, 1,500 tons.

"The Frechette mine has been at work only one year, with an output of about 200 tons.

"The Lionais-Martin mine, now the Scottish Canadian Company, has done a large amount of exploratory work. Its estimated output for 1886 may be stated at 250 tons, with a total from the commencement of, say 700 tons.

"The cost of mining here varies but little from that of Thetford, and may be stated as averaging $25 per ton.

"In the vicinity of Black Lake several other areas occur, in which the exploratory work done, though not very extensive, shows indications that fully warrant the statement that a valuable and profitable output may be expected. These properties are known as the Reed and Hayden properties, and are situated on Lot 27 and 28, Range B, Coleraine. In various open cuts in the side of the hills numerous veins are disclosed, ranging upwards to a width of two and a half inches, with surface indications apparently in no way inferior to those of the adjoining properties now being worked at this place, or even of those of Thetford, not only as to number and size of veins, but also as to quality of fibre. These indications appear at many points on both the Hayden and Reed properties, which embrace a total of 200 acres. Between these and Caribou Lake the serpentines extend as an apparently continuous ridge, and show at intervals very good indications of asbestos, but this portion has not as yet been explored to any extent, and but little can be said from actual examination of the value of this section of the serpentine belt, though that it will be found equally productive with adjoining areas seems reasonable.

"In the vicinity of Coleraine Station serpentine also occurs, but the main ridge,

extending south-west from Black Lake, keeps to the north-west about one mile and a half, where it forms a conspicuous hill feature. This has been but little examined, but an opening was made on its south-east extremity during the present year by Mr. Kennedy, disclosing the presence of a number of veins of asbestos, one of which had, near the surface, a thickness of nearly four inches. Sufficient work was not done to determine the persistence and value of these veins. An interesting feature in connection with this opening is the presence of mica in considerable quantity in direct contact with the asbestos, a feature not as yet noted at any other point.

"The asbestos area of Wolfestown is situated on the north-east extremity of a serpentine ridge, which extends south-westerly, with several interruptions from the road leading from Coleraine Station to Wolfestown, to the vicinity of Lake Nicolet. It is owned by Mr. John Bell, of London, Eng., and though a considerable sum of money has evidently been spent on this property it has been largely in the way of explorations. The surface indications, while not equal to those of Black Lake, yet show at several points numbers of veins, some of which reach a thickness of one and a half and even two inches. Only a small force of men is employed, and the property cannot yet be said to be fairly proved. Considerable deposits of chrome iron are found in the hills on this area, which embraces 600 acres. At present it would be exceedingly difficult to give any decided opinion as to the merits of this property. A very fair showing of workable veins has been exposed in the upper part of a deep cut which it is now proposed to intersect at a considerably lower level. Should the same rule of increase which holds at Black Lake and Thetford apply here, there should be good paying ground when the lower level is driven in past the capping of barren rock, provided the veins already disclosed are not cut off by faults, whose presence is noted here as at other points. The total amount of asbestos taken from the Belmina area is about twenty-five tons.

"In addition to the properties already described the only other point where this mineral is worked successfully is on Lot 9, Range 3, Shipton, about four miles from Danville on the Grand Trunk Railway. The outcrop of the serpentine here is quite limited, with steep sides all round, and contains a number of veins of asbestos, mostly of small size though the quality of the fibre is good. Faults have affected the value of this property considerably, some very good veins with a thickness reaching two inches having been cut off completely at a depth of 50 feet from the surface. The output, however, is considerable, for the year ending 28th August, 1886, being 455 tons, but from various causes it is at present much less, the mine not being worked to its full capacity.

"It will be seen from the facts here presented that the asbestos interests of the province are very important, and judging by the ratio of increase for the last six years will soon assume large proportions. The demand is annually increasing as new uses for the raw material as being found, and from the prospects presented not only at the mines already opened, but in those areas contiguous and which appear equally rich, the supply is practically limitless.

"During the past year attention was directed to the deposit of marble situated near Marbleton, in the Parish of Dudswell. This was described by the late Sir Wm. Logan in the Geology of Canada, 1863, p. 827. A great variety of marble is here presented, some of which are very fine, notably a black ground, with veins of ochre yellow. Though the deposits of marble in the vicinity have been extensively used for some years for the manufacture of lime, the desirability of utilizing the finer grades as marble was such that a company was formed during the past year for this purpose. The ground has been cleared and a channelling machine set to work. The extent of the present quarry is about forty feet square. The black and gold variety is interbedded with others of dove-grey and variegated shades, all of which present a fine appearance when polished, some bands entirely composed of fossils (corals) notably so. The rock bids fair to be sufficiently solid to extract valuable blocks of large size in the second cut, and it is the intention of the company to erect in that case sawing and polishing machinery for its manufacture.

The work of the season began on the 17th of May, and extended to the 1st of November.

Expenditure in connection with work, $1,560.

At the end of July Mr. H. M. Ami was instructed to join Mr. Ells in the Eastern Townships for the purpose of assisting him in collecting fossils and examining the various fossiliferous localities which had been discovered, with the view of fixing the age of parts of the rock series of the district. Messrs. Ami and Ells together obtained about five hundred specimens from various places near Lake Memphremagog, in Stukely, Stoke and Dudswell; along the Chaudière River, Quebec City, Montmorency and the Island of Orleans.

Rev. Professor J. A. K. Laflamme having consented to continue the work previously carried on by him in connection with the accurate definition of the boundary of the Cambro-Silurian on the Archæan to the north of the St. Lawrence, and the areas respectively occupied by the various subdivisions of the formation, sketches the result of his labors as follows :—

"I have traced on the map with as much precision as possible the limits of the Laurentian and Cambro-Silurian formations between Quebec and Three Rivers, as as well as the several divisions of the Cambro-Silurian which are found in this part of the country. I have, however, unfortunately, been unable to complete the stratigraphical study of the region immediately surrounding the city of Quebec.

"The geological map received from Ottawa for use as a basis of work was found exact in its principal lines. Some slight errors which I have noted have been carefully corrected, and will be indicated on the map which will be submitted with my report.

"Certain facts which appear worthy to be remarked are as follows :—

"(1.) The discovery of some small deposits of apatite in the Canton de Caxton merit special attention, as it is not impossible that more important deposits will be found in the future, as the Laurentian gneiss of the neighborhood is traversed in different directions by veins of crystalline calcite, rich in mica and pyroxene.

"(2.) The great thickness and quantity of sand which occurs on the banks of the St. Maurice renders the observation of the exact limits of the different geological formations impossible, particularly as regards the boundary of the Utica and the Trenton limestone. The sand contains a great quantity of ferrugenous matter, giving rise to abundant deposits of limonite wherever the surface is occupied by swamp. Thus in this part of the country we find the most ancient iron furnaces of Canada, several of which are now, however, not in operation, owing to the scarcity of fuel.

"(3.) The Utica shales preserve there one of their distinctive characters in giving rise to strong and highly saline, mineral springs, the therapeutic value of which has long been known.

"(4.) The same shales with the subjacent Trenton limestones produce considerable quantities of light carburetted hydrogen, almost pure, and capable of being utilized at several places very profitably. One in particular of these flows of combustible gas occurs quite close to the old forges, abandoned on account of the scarcity of fuel, and there, it appears, all the conditions exist which would justify boring operations with the object of augmenting the flow of gas, for the purpose of resuming the smelting operations. The boring made at St. Grégoire leads to the belief that the gas is stored principally in the Utica shales. If this be the case it would be necessary only to sink wells through the thick bed of clays which cover this formatiom here to produce an abundant flow of gas.

"(5.) The Trenton limestones have a great development at St. Alban, where are found the well known quarries which yield the best building stone of the Province of Quebec. The limestone is crystalline and fossiliferous. The quarries yield annually from four to six thousand toises of stone.

"(6.) The study which I have made of the immediate vicinity of Quebec, though superficial, leads me to the belief that there are on the northern side of the rock mass

of this vicinity tongues of Utica shale. These would be somewhat analogous stratigraphically to those shown by Sir W. E. Logan's section of the Island of Orleans. It appears to me impossible to class as Trenton the whole of the exposures comprised between the left bank of the river and the heights of Beauport, Charlesbourg and Lorette.† There is quite close to the edge of the Laurentian a band of variable width of Trenton limestone, but the remaining space is occupied by shales very like those which are again found to the south-east of the Montmorency Fall, between the fall and the river."

Prof. L. W. Bailey was again occupied during the summer in the geological survey of New Brunswick, with the object in view of completing the sheets of the geological map yet remaining unfinished. Prof. Bailey was personally assisted during the season by Mr. J. W. Bailey. His preliminary account of his work, with that of Mr. W. McInnes in the same Province, is given below.

"In accordance with instructions, my own attention was directed chiefly to the study of the Silurian system of northern New Brunswick, with a view to the determination of the succession of its rocks and their relations to the formations above and below it. With this object in view, examinations begun in the previous year on the northern side of the Silurian basin where it comes into contact with the rocks, supposed to be of the age of the Quebec Group, in the vicinity of Lake Témiscouata, were renewed and extended both easterly and westerly, while an examination was also made of the neighboring portions of Aroostook County, Maine, where the same Silurian rocks are associated with others which have been supposed to be Devonian. The result of these examinations was to show a general parallelism between the succession of rocks as seen on Lake Témiscouata, on the northern side of the Silurian tract, with that previously made out on its southern side, on the Beccaguimie River, in Carleton; while portions of the rocks of Aroostook County, previously regarded as Devonian, would seem also to occupy a position in the Silurian system. The final determination of these points, however, is largely dependent upon the examination of their contained fossils. Of these somewhat numerous collections were made on Lake Témiscouata, on the Tuladi and Squatook Rivers, at Squaw Lake, Maine, and at Ashland and along the course of the Aroostook River in the same State. These are now in the hands of Mr. Whiteaves and Mr. Ami.

"The work in the Témiscouata region has already sufficed to show, irrespective of fossils, that a considerable area about the lake of that name, regarded by Sir W. E. Logan as of the age of the Quebec Group, is at least as recent as Silurian, while other areas to the north, referred to by Mr. Richardson to the Silurian, really belong to the more ancient Cambro-Silurian system. A complete exploration of the region intervening between the Témiscouata Portage Road and Lake Metapedia on one side, and between the same road and the Chaudière district on the other, is required before the real structure of this region can be fully understood.

"The especial object of the work carried on by Mr. McInnes was the completion of the information necessary for sheets No. 2 south-west, and 2 north-west of the geological map of New Brunswick, on which Mr. McInnis reports as follows:—

"I left Ottawa on the 3rd of June and arrived at Fredericton on the 9th, spending three days, in passing, in a brief examination, in company with Mr. Ells, of the region about Lake Témiscouata. After a week in Fredericton, occupied in making tracings of Crown Land plans and in completing arrangements for the season's work, I started for the upper St. John district on the 14th of June. Arriving a Andover, advantage was taken of the high water prevailing in the streams to make a survey by micrometer telescope of the right hand branch of Tobique River, of Campbell

† This is quite true, but there seems no great difficulty in considering them to represent the Trenton group, *i. e.*, the Chazy, the Birds-eye, Black River, Trenton, Utica and Hudson River formations. In any case the fossils of the Citadel Hill rocks ally them more closely to the Trenton group than to the Levis, the graptolitic fauna of which belong to a much older horizon. The main point now to be decided is whether the Citadel Hill rocks are below or above the Trenton and Black River limestone foundations.—A. R. C. Selwyn.

River and of Trousers, Long, and Serpentine Lakes; in descending the Serpentine, a sketch survey of that stream was also made. The country passed through on this exploration lies mostly within the pre-Cambrian and intrusive granite areas, the latter extending from Little South-West Miramichi Lake across to a point about midway between the outlet and inlet on Long Lake, and the former occupying most of the district between the granite and the main Silurian area.

"The region in general is very rough and broken with high hills and ridges, and the surface often thickly strewn with large blocks and boulders of the underlying hard crystalline rock. The forest growth is chiefly black spruce and fir, mixed with cedar along the watercourses, and with scattered pine, birch, mountain ash, &c. What is probably the first representative, yet noticed in New Brunswick, of the Oriskany sandstone, so common in the neighboring State of Maine, occurs near the confluence of the Don and Campbell Rivers. A broad band, three miles or thereabouts in width, of buff weathering dolomitic sandstone, with fossiliferous layers, crosses the river at this point. This seems to be an isolated patch lying upon the older rocks which has escaped the general denudation.

"In the latter part of July two weeks were spent in making odometer surveys of the roads between Edmundston and St. Francis, in Madawaska county, and between Edmundston and Notre Dame du Lac, Témiscouata, chiefly for the purpose of topographical detail. During August a micrometer survey was also made of Lake Témiscouata, and a sketch survey of Horton Branch of Tuladi River.

"The remainder of the season, September and part of October, was spent in exploring the region lying between the Tobique and Campbell Rivers by ascending the stream flowing into the Tobique from the south and by a paced survey of the portage road to Trousers Lake. This whole area is very hilly and rough, and presents a marked contrast to the rest of the valley of the Tobique below the forks, where the soft and calcareous character of the Silurian and Lower Carboniferous strata has produced a soil of great fertility with numerous fine alluvial flats and islands which, when cleared of the large elms and balsam poplars with which they are generally wooded, form nice meadow lands. Extensive beds of gypsum, which occur near the summit of the Lower Carboniferous outlier, add to the value of the lands.

"Collections of fossils were made from the Silurian beds on Campbell River and Riley Brook, which are in the hands of the palæontologist of the survey for identification.

"Leaving Fredericton on the 20th October after a few days spent there in packing and labelling specimens, &c., I arrived in Ottawa on the 22nd and resumed work in the office.

"During the summer about 200 miles of lakes and streams were surveyed with the Rochon micrometer telescope, 100 miles of roads with the odometer, and about 70 miles of rough roads and streams by pacing and sketch surveys."

Expenditure in connection with field work $1,579.67.

Mr. R. Chalmers left Ottawa on the 1st June, with instructions to work out in detail the surface geology of the districts comprised within the two quarter sheet maps, 2 N.E. and 6 S.W., New Brunswick. Mr. Chalmers' preliminary statement with regard to the work carried out is as follows:—

"Certain sections included in sheets 3 S.E. and 3 S.W., the surface geology of which was investigated during the previous summer, had first to be further examined to obtain additional data to complete these maps, and accordingly a part of June was devoted to this object. On finishing this I started on a canoe trip to explore Shippegan and Miscou Islands and the adjacent mainland, and then ascended the Nepisiquit River to the limit of the map. Thence I crossed over to the North-West Miramichi River, and examined the intervening country as well as portions of that lying north of the Nepisiquit as far as time would permit. The general elevation and topographic features of this interior region were noted, and some points of interest, relative to the peculiar character of the Nepisiquit as a drainage channel, observed. Immediately thereafter I went up

the North-West Miramichi from Newcastle, and on the return trip ascended its affluent, the Little South-West, some distance. Interesting observations on the country drained by these rivers, and on the terraces and intervales skirting them, were made. Subsequently another canoe trip was made down the Miramichi Bay and the coasts and islands examined as far as Portage Island and Escuminac Point. These explorations occupied my time till about the middle of September. The remainder of the season was devoted to the study of the character and distribution of the deposits in those sections lying at a distance from the coasts and rivers and in mapping the forest-covered areas. All back settlements and places accessible by roads of any kind were visited. The old Indian camping grounds at Tabusintac and Derby were also explored and some relics found.

"The investigations of the season have resulted in showing a much wider extension of pre-glacial gravels and sands than was hitherto supposed to exist in New Brunswick. From the evidence afforded in numerous sections in different parts of the area under discussion it would seem that they must have formed a general covering of some thickness, especially upon the flat Carboniferous plain, and probably mantled the crystalline rocks of the interior as well, although the proofs of this are not so abundant. These gravels were no doubt considerably reduced in bulk previous to the advent of the ice age, by atmospheric erosion, especially on the latter tract, or wherever the country was hilly or had an uneven surface, and along the lines of drainage. Near the coast large areas are still covered by them, however, but overlain by stratified materials. Either the ice of the glacial period has passed very lightly over the tract, or it has been unglaciated, and was probably submerged during the greatest extension of ice.

"Some interesting facts were observed regarding boulder distribution. Blocks of granite, felsite, gneiss, diorite, &c., are abundantly strewn over the whole area examined. These together with the courses of striæ show that the general ice movement as stated in my preliminary report, Annual Report, 1885, page 56G, was eastward or north-eastward from the higher grounds of the interior. Besides this, however, other and probably smaller local glaciers followed the valleys in different directions. The boulders of crystalline rocks met with below the 200 feet contour line do not now occupy the sites to which they were borne by glacier ice, but appear to have been shifted about by floating ice since on the shores of the receding post-Tertiary sea as they are found almost wholly on the surface.

"Within the Miramichi basin no marine terraces were found at a greater height than 150 to 160 feet above sea level, and it therefore seems probable that the post-Tertiary subsidence was hardly as great there as in the Baie des Chaleurs district.

"Regarding river terraces a number of facts were collected which serve to throw light on their origin and on the relation they bear to the rivers which formed them. The Litte South-West Miramichi, the most rapid river in north-eastern New Brunswick, has the highest and finest terraces.

"Close attention was given to the agricultural character of the country examined. Large intervales and considerable tracts of good uplands were seen along the Miramichi Rivers.

"Observations were also made regarding the forest growth. The approximate limits of the burnt forest areas, particularly that of the great Miramichi fire of 1825 were located, and the extent of country cleared and inhabited was likewise noted.

"Extensive beds of peat were observed at Point Escuminac, Tabusintac, Miscou Island and elsewhere near the coast. The bottoms of these seem now to be slightly below high tide level, and their thickness in some places is known to be upwards of 20 feet. They apparently owe their growth to proximity to the sea, where the conditions of temperature, moisture, &c., are favorable. Sand beaches, drift wood, and in one instance a charred log, were found at the bottom of these peat deposits.

"Beaches of blown sand are characteristic features of the coast along the Straits of Northumberland. They appear to have been produced by the action of the sea along a shallow, stationary coast margin. Under some of these rock, *in situ*, was seen

nearly as high as sea level. A singular beach formation is now being thrown up at the north-east point of Miscou Island in which the bones of the walrus were found.

"The field work was brought to a conclusion on the 11th of November."

Expenditure in connection with field work, $821.97.

Mr. Fletcher and assistants were engaged during the season in continuing and extending the geological work carried out by them in Nova Scotia in previous years. It was found advantageous to detach Mr. Faribault for the investigation of a separate district. The following summary of the work of both parties is presented by Mr. Fletcher, that portion referring to his own exploration having been supplied by Mr. Faribault:—

"To the westward of the district referred to in the Summary Report of 1885, page 20, surveys were made during the summer of 1886, so that a geological map can now be constructed of all that portion of Nova Scotia lying east of longtitude 62° 30', and including the whole of Antigonish and Guysborough counties and part of Pictou and Halifax counties.

"Mr. Faribault was again put in charge of the work among the gold-bearing rocks of the Atlantic coast. Mr. Robert assisted me in Antigonish and Pictou counties, and was for a long time engaged in mapping out the plications of the Lower Carboniferous rocks and their relation to the metamorphic rocks of the hill ranges.

"The general distribution of the Carboniferous rocks over most of this area was described in the above mentioned Summary Report. Many additional details of structure have, however, been obtained, and the various basins into which the different sub-divisions can be separated have been carefully traced. The Carboniferous limestone runs in a narrow belt along the eastern shore from Antigonish to Morristown, and a patch of this formation occurs also at the mineral spring in Hallowell Grant; but the greater part of the Carboniferous rocks between Antigonish and Cape George, including the so-called coal mines of Malignant Brook, Hallowell Grant and other places in the neighborhood, belongs to the "Metamorphic Carboniferous," Horton or Basal conglomerate group. Underlying the Lower Carboniferous at McAra's Brook, is a small area of red and greenish slates and sandstones, apparently Upper Devonian, from which Mr. Weston obtained certain tracks and fossil plants. Beneath these lie the Silurian rocks of the well-known Arisaig shore, running in a narrow belt eastward to McNeil's Brook, and underlaid by Cambro-Silurian and perhaps older rocks. In addition to this Silurian area several others were found in the region in question. (1) Two small patches on the sea shore at Cape George; (2) a small patch west of Vamey's Brook; (3) a long narrow basin in the deep picturesque valley along the railway from James' River to the west end of Marshy Hope; (4) a broader belt extending from Bailey's Brook to Avondale, thence up Barney's River to Kenzieville, thence along the telegraph road to Glenshee, thence to the St. Mary's road at McPherson's mills to join the area of pre-Carboniferous rocks shown on Sir Wm. E. Logan's and Hartley's map of the Pictou coal field, a large part of which, however, belongs to the underlying Cambro-Silurian; (5) a small patch at Moose River; (6) the broken basins north of the East River of Pictou extending from the vicinity of Beaver Lake down stream towards Springville, and described by Sir J. W. Dawson in Acadian Geology, and by Dr. Honeyman in the Transactions of the Nova Scotian Institute of Natural Science.

"But by far the greater part of the districts underlaid by pre-Carboniferous rocks is occupied by rocks older than Silurian, those containing the iron ore at Londonderry mines (probably Cambro-Silurian), and by a series of felsitic, mica, hornblende, chlorite, talc and other schists resembling those in the Cobequid Hills called Archæan by Mr. Ells, but which have not yet been examined with sufficient care in Antigonish and Pictou counties to determine that they are not a part of the Cambro-Silurian series. On the sea shore at Arisaig and Georgeville are exposures of very crystalline limestone and other rocks, which have been referred to the Archæan, but

of which no more can be at present affirmed than that they form pebbles in certain conglomerates, which are apparently Cambro-Silurian.

"In the Cambro-Silurian strata only a few obscure fossils were found at McNeil's Brook, where also, as well as in the Malignant and Doctor's Brooks, deposits of red hæmatite, probably of great thickness and value, have been exposed in many places; but the want of a convenient shipping place has hindered the development of these ores. Iron has also been found in Barney's River, French River and other places. Small quantities of the precious metals are reported to have been found in the numerous quartz veins of the Cambro-Silurian rocks at Vamey's Brook, Bailey's Brook, Rights River, Malignant Brook, Georgeville and other places; but nothing to warrant the belief that they exist in paying quantity was seen by us.

"In addition to the coal found in the Lower Carboniferous as stated above, it has been sought, of course in vain, in the black Silurian slates of Arisaig, Kerrowgare and other places.

"Traces of copper and lead have been found in all of the formations above described, as at Arisaig, Moose River, Blue Mountain, and other places, but apparently not of economic importance. The innumerable veins, usually of white quartz, cut the Cambro-Silurian rocks as at Sutherland River, and seem to be invariably barren.

"Mr. Faribault was assisted during the season by Mr. M. H. McLeod, and part of the summer by Messrs. A. Cameron, G. B. Faribault and A. H. McLeod.

"The first four months were spent in making a detailed topographical and geological survey of the country lying between the Liscomb and Sheet Harbor Rivers and the Atlantic coast. The country examined consists entirely of the gold bearing rocks (lower Cambrian?) which are much less altered than those seen last year in the vicinity of the granite dykes south of West River, St. Mary's. No fossils, however, could be found in them. Some seven miles up Ecum Secum River, many Upper Silurian fossils were discovered in the drift, but whether they were carried from Antigonish county or belong to an isolated patch of the Upper Silurian in the gold-bearing rocks, could not be ascertained. Much attention was paid to the stratigraphy of these rocks with the view of ascertaining the position of possible new gold districts.

"The only gold mine now being worked in the region surveyed is the well-known Salmon River mine, where much work is still being done with very good returns. The following gold mines, not worked at present, were also examined:—Hattie's mine, quarter of a mile east of that at Salmon River, Harrigan Cove mine, Moose Head mine and Ecum Secum mine. Besides the quartz leads which have been prospected at various places and are known to contain gold, many quartz veins of very good appearance were also seen at the head of Moser's River.

"Over a month was employed in the latter part of the season in revisiting the country previously surveyed along the south shore from Liscomb River to Cape Canso, in order to obtain more definite information relating to the general structure of the gold-bearing rocks, the map and report of which will be ready for publication next spring. A large number of rock specimens, illustrating the alteration of the various strata as they come near the granite, was collected. Five hundred and thirty-eight miles of stream and 130 miles of roads were measured by Mr. Faribault, and many heights taken with the barometer.

"Field work was begun on the 2nd of June and continued till about the end of November."

Expenditure on exploration, under Mr. Fletcher's charge, about $2,000.

PALÆONTOLOGY AND ZOOLOGY.

Under these headings Mr. Whiteaves reports that the systematic catalogue of the zoological specimens contributed by the Department of Fisheries to the Colonial and Indian Exhibition, of which mention was made in last year's report, has been revised and published in the shape of an octavo pamphlet of 42 pages, 1000 copies of which have been distributed in London.

The study of by far the larger portion of the extensive series of recent marine invertebrata dredged or otherwise collected by Dr.G.M. Dawson and Mr.D.B. Dowling, in 1878, in the Strait of Georgia, Discovery Passage, Johnstone Strait and Queen Charlotte and Quatsino Sounds, as well as that of the whole of the marine fishes, birds and other vertebrates from the same region, has been completed, and a paper upon them which is now in the printer's hands, has been read before the Royal Society of Canada at its last meeting. All the species of Foraminifera, Anthozoa, Echinodermata, Brachiopoda, Mollusca, Ophidians, Batrachians, birds and mammals, have been determined and labelled, and the duplicates made up into sets for distribution, as far as the time would permit. The Crustacea obtained in these dredgings have been sent to Professor Sidney J. Smith, of Yale College, and the hydroids and polyzoa to the Rev. Professor Hincks, of Leigh Woods, near Bristol, England, who have kindly promised to report upon them.

A paper entitled "Illustrations of the Fossil Fishes of the Devonian Rocks of Canada," which is also now in the press, has been prepared and read at the last meeting of the Royal Society of Canada. This paper, which is illustrated by five quarto plates, contains fuller descriptions than have yet been published of four out of the eight remarkable species discovered in 1880 and 1881 in the Upper Devonian rocks at Scaumenac Bay, Que., and the homologies of the Canadian *Pterichthys* or *Bothriolepis* are discussed at some length.

A considerable portion of the letter-press of Part II of the first volume of the "Contributions to Canadian Palæontology" has been written, and the lithographic plates required to illustrate it have been prepared. This report, which it is hoped will be issued early in the spring of 1887, will contain descriptions of the fossils, and more especially of the crinoids and blastoids, of the Hamilton Formation of Western Ontario.

A preliminary examination has been made of the large and interesting collections of Palæozoic and Mesozoic fossils made this year by Mr. R. G. McConnell in the Rocky Mountains, and of the Cambro-Silurian or Silurian fossils collected by Mr. A. P. Low on the Fawn branch of the Severn River.

The skeleton of the Harp Seal obtained by Mr. T. C. Weston in 1861, from the Post-Pliocene clays of Montreal, and that of the White Whale or Beluga (*Delphinapterus catodon*) found in deposits of similar age at Cornwall, Ont., in 1870, have been skilfully articulated by Mons. Jules F. D. Bailly, and now form conspicuous objects in the upper flat of the Museum.

Sixteen additional specimens of mammalia, six of which are seals, and thirty of birds, have been mounted and placed on exhibition during the year, and the number would have been greater but for the fact that Mr. Herring's time up to the first of April, was occupied in cleaning and remounting a large number of specimens of birds, &c., which were sent to the Colonial and Indian Exhibition. All the species added to the Museum during the year in the Department of zoology, a list of which will be found on pages 33–37, have been examined and determined, and the whole series of mammals and birds now in the cases has been re-labelled and re-arranged. Some progress also has been made in the labelling and classification of the numerous specimens of fossils and recent invertebrates that have also been lately added to the Museum.

The number of letters written is 270, many of which partake of the nature of "reports."

Most of Mr. T. C. Weston's time has been spent in Museum work, in the classification and arrangement of the Carboniferous, Cretaceous and Laramie fossils, in conjunction with Mr. Ami, in labelling and planning the arrangement of specimens of gold, *Eozoon*, &c., selected for transmission to the Colonial and Indian Exhibition, and in field exploration.

During the month of July, August and September, he made large collections of fossils and lithological specimens from the Carboniferous, Devonian and Silurian rocks of Nova Scotia and Cape Breton. A list of these fossils, with other information, will be embodied in a forthcoming report by Mr. Hugh Fletcher.

Mr. Weston has also visited Côte St. Pierre, where he has collected as large a series of specimens as possible of *Eozoon* for exhibition in the Museum and for distribution.

Mr. H. M. Ami has been occupied chiefly in the classification and labelling of fossils in the Museum. All the species enumerated in Mr. Whiteaves' recently published Report on the Invertebrata of the Laramie and Cretaceous rocks of the Bow and Belly Rivers and adjacent localities in the North-West Territories, and the fossil plants of the "Jurasso Cretaceous," Cretaceous and Laramie rocks of the North-West Territories, described by Sir William Dawson in 1885 and 1886, have been labelled, classified and placed upon exhibition in the Museum. A number of fossils from the Devonian rocks of the North-West and Hudson's Bay Territory, and the whole series of fossil plants from the Carboniferous formation of New Brunswick, Nova Scotia and Cape Breton, in the possession of the Survey, have also been labelled and classified.

Collections of fossils made by Professor L. W. Bailey, Messrs. Hugh Fletcher, W. McInnes and W. H. T. Reed, at various localities in the provinces of Quebec, New Brunswick and Nova Scotia, consisting in all of some eight hundred specimens (some of which appear to belong to species not previously represented in the Museum) have been examined with a view to determine, as far as possible, the exact geological horizons of the rocks from which they were collected, The Palæozoic fossils collected by Mr. R. G. McConnell in 1885 from eight different localities in the Rocky Mountains, and in the early part of the season of 1886 from the Bow River Pass, have also been examined and provisional reports thereon prepared. The Cambro-Silurian fossils collected by Mr. F. D. Adams, in 1885, at Lake St. John, and those collected by Colonel Grant on the Island of Anticosti in the same year (which latter were sent to the Colonial and Indian Exhibition). have been studied, and the species determined.

Collections of duplicate fossils, &c., have been sent to the Redpath Museum at Montreal, to the Museums of Queen's University, Kingston, and of the University of Fredericton, N.B., also to those of the Agassiz Association of Montreal, and of the public schools at Berlin and Blair, Ont.

During two months of the year Mr. Ami has been engaged in the field in the examination of fossiliferous rocks at various localities in the Eastern Townships of the province of Quebec, and in Central Ontario, with the object of determining their exact geological horizons, as already stated on pages 19 and 26.

The following collections have been received during the year from members of the staff or gentlemen engaged in the work of the Survey:—

R. Bell:—

One Harp Seal (*Phoca Grœnlandica*) from Blanc Sablon.
One Peregrine Falcon (*Falco communis*) from Cape Chudleigh, Labrador.
One Gyr Falcon (*Falco sacer*) also from Cape Chudleigh.
One King Eider (*Somateira spectabilis*) from Ashe's Inlet, Hudson's Strait.
One Long-tailed or Buffon's Skua (*Stercorarius Cepphus*) from Cape Chudleigh
One Glaucous Gull (*Larus glaucus*)from Resolution Island, Hudson's Strait.
One Ivory Gull (*Pagophila eburnea*) from Resolution Island.
One Kittiwake Gull (*Rissa tridactula*) from Cape Chudleigh.
One Fulmar Petrel (*Procellaria glacialis*) from Resolution Island.
Two Black Throated Divers (*Colymbus arcticus*) from near Cape Digges, Hudson's Bay.
Thirty-six specimens of fossils from the Albany River between its mouth and the forks.
Twenty-one specimens of fossils from the Attawapishkat River.

R. G. McConnell:—

(From the Rocky Mountains near the line of the Canadian Pacific Railway):—

One specimen of the Hoary Marmot or "Siffleurs' (*Arctomys pruinosus*) from mountains near Devil's Head Lake.

One specimen of the Rocky Mountain variety of Parry's Marmot (*Spermophilus Parryi*, var B.) from the base of Castle Mountain.
One specimen of the Missouri Ground Squirrel (*Tamias quadrivittatus*)) from the base of Grotto Mountain.
One Red Squirrel (*Sciurus Hudsonius*, var.) from the base of Wood Mountain.
One Virginian Owl (*Bubo Virginanus*) from Gap Siding, C.P.R.
About 700 specimens of Palæozoic and 100 of Mesozoic fossils.

J. B. Tyrrell and D. B. Dowling :—
(From the Upper North Saskatchewan and its vicinity.)
From Coyote or Prairie Wolf (*Canis latrans*) from Egg Lake.
Two Badgers (*Taxidea Americana*) one from Sounding Creek, and one from Dried Meat Lake, near the Battle River.
One Striped Gopher (*Spermophilus tridecemlineatus*) from Nose Creek.
Two Northern Pocket Gophers (*Thomomys talpoides*) from near Edmonton.
One specimen of the western variety of the White Footed Mouse (*Hesperomys leucopus*, var. *occidentalis*.)
One specimen of Cooper's Shrew (*Sorex personatus*) from Pigeon Lake.
Fifty-two skins of Birds, including three Magpies (*Pica melanoleuca*, var. *Hudsonica*), one Swainson's Buzzard (*Buteo Swainsonii*), two Avocets (*Recurvirostra Americana*), one Wilson's Phalarope (*Steganopus Wilsoni*), one Black-tailed Godwit (*Limosa Hudsonica*), two Willets (*Totanus semipalmatus*), two Upland Plovers (*Actiturus Bartramius*), one White Pelican (*Pelecanus trachyrhynchus*), and two Sooty Terns (*Hydrochelidon larifomis*.)
Eggs of Swainson's Buzzard, Avocet and Upland Plover.
One hundred and twenty five butterflies, and a small series of fresh-water shells.
About four hundred specimens of Cretaceous and Tertiary fossils.

T. C. Weston:—
Six hundred and eighty specimens of fossils from various localities near Arisaig, N.S.
Twenty-four specimens of fossils from Lochaber, Antigonish County, N.S.
Thirty-six do do do Escasoni, C.B.
Eighty do do do George River, Bras d'Or, C.B.
Forty-five do do do Lévis, Que.
One hundred and twenty-five fossil plants from the Devonian rocks at various localities in Nova Scotia.

A. P. Low :—
Fifty-four specimens of fossils from the Cambro Silurian or Silurian rocks of limestone rapid on the Fawn branch of the Severn River.

A. C. Lawson :—
Black variety of the Wood chuck (*Arctomys empetre*) and five fresh-water shells (three *Unio luteolus* and two *Anodonta Footiana*) from Rainy Lake.

H. M. Ami :—
About one thousand specimens of fossils from the Cambro-Silurian and Silurian rocks at various localities in the Provinces of Quebec and Ontario.
Seventy-two specimens of fossils from the Post-Pliocene nodules of Green's Creek, near Ottawa, Ont.

L. W. Bailey :—
About six hundred specimens of fossils, chiefly of Silurian age, from different localities in the Province of Quebec and New Brunswick or from the adjacent parts of Maine.

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.

ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

THE PROPERTY OF THE GEOLOGICAL SOCIETY OF THE PEOPLE

SUMMARY REPORT

OF THE

OPERATIONS of the GEOLOGICAL and NATURAL HISTORY SURVEY

To 31st December, 1887,

BEING

PART III

ANNUAL REPORT OF THE DEPARTMENT OF THE INTERIOR,

1887.

2-5-10

OTTAWA:
PRINTED BY MacLEAN, ROGER & Co., WELLIN
1888.

ROYAL GEOGRAPHICAL SOCIETY OF THE PACIFIC

GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.

ALFRED R. C. SELWYN, C.M.G., LL.D., F.R.S., DIRECTOR.

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1888.

GEOLOGICAL SURVEY.

DEPARTMENT OF THE INTERIOR,
GEOLOGICAL AND NATURAL HISTORY SURVEY AND MUSEUM BRANCH,
OTTAWA, 31st December, 1887.

To the Hon. THOS. WHITE,
Minister of the Interior,
Ottawa.

SIR,—I have the honor to submit herewith the annual report on the work accomplished during the past calendar year by this Branch of the Department of the Interior, together with brief summaries by the officers in charge of the several explorations and investigations. As in past years these explorations have embraced many parts of the Dominion, and have during the past season extended from Vancouver Island and the A'askan and northern borders of British Columbia, to James' Bay and the Atlantic coast of Nova Scotia, as well as to portions of the provinces of New Brunswick, Quebec, Ontario and Manitoba.

Much new and valuable geological and geographical information has been acquired, and large and interesting additions have been made to the Museum collection.

The Annual Report for 1886, Vol. II, new series, has recently been issued. This volume of 977 R. Vo, with numerous maps and illustrations, is composed of thirteen parts, or distinct reports, giving, in detail, the scientific and the practical information, and the conclusions arrived at respecting the various portions of the country explored, or on the other subjects treated of. The parts are also published separately, and are sold at an average price of twenty-five cents each.

My own time, during the early part of the year, after my return from England, at the end of December, 1886, was fully occupied in the preparation of the Annual Departmental report, with the general executive details of the Branch, and in connection with the preparation of the Annual Report, Vol. II, above referred to.

During the summer, between the 13th June and the 10th of October, I visited and examined various places, between Gaspé Bay and Cape Rosier in Quebec, and Vancouver Island in British Columbia, where the work of the Survey is in progress, and where some personal observation was required, either for information on points of economic importance, or in connection with the working out the geological structure of the region. Of these may be mentioned: the occurrence of petroleum at Gaspé; the relations of the graptolite bearing rocks of Cape Rosier, Matane and Bic to those of Point Lévis, the Island of Orleans and Quebec; the cupriferous pyrrhotite mines of Sudbury; the silver mines and the iron ores of the vicinity of Port Arthur; the coal mines of Lethbridge and of Banff; the silver-lead mines of Illicillewaet, in the Selkirk Mountains; and the hot springs of Harrison Lake and of Banff.

As regards the Gaspé petroleum, no efforts appear to have been made to develop it since 1863, and beyond the fact of the recent discovery of oozings at a point higher up Silver Brook than where the first boring was made, there is no further information about it now than was given in the Geology of Canada, 1863, pages 402, 521 and 789, and in the report by Dr T. Sterry Hunt, published in 1865, "On Petroleum, its Geological Relations considered with special reference to its occurrence in Gaspé." Three borings appear to have been made, the sites of which are marked on the geological map, ¼ sheet, 6 N.W., but as none of them exceeded 200 feet, a successful result was hardly to be expected. The development of the extraordinarily massive, cupiferous ore bodies in the vicinity of Sudbury was being actively prosecuted by the company. The manager informed me that 2,000 tons of the ore had been shipped to the Messrs. Vivians, of Swansea, Wales, and on their report depends the question whether the Sudbury ores can or can not be profitably worked. This ore-belt has now been definitely traced for eight miles, and outcrops of large

bodies of ore have been found at intervals throughout. In view of the immense quantity of ore, the small cost of raising it, and the facilities for shipping it, a very low price per ton would leave a fair margin of profit.

The argentiferous galena of Illicillewaet occurs chiefly in quartz veins, cutting a series of black carbonaceous or graphitic slaty shales, and thin bedded limestones, often much folded, but showing an average dip of from 35° to 40° to E N.E., and apparently flattening towards the summits of the mountains. Most of the veins are parallel with the stratification, though not infrequently passing from one bed plane to that of another. The openings on Kennedy & Corbyn's claim, No. 2, above the north fork of the Illecillewaet River, and about 5,300 feet above sea level, on a precipitous mountain side, show a massive quartz vein in an almost vertical attitude, cutting the black slates which are here almost horizontal. The quartz is impregnated throughout with galena and some pyrites, and is said to be very rich in silver. A large pile of ore had been extracted, but as the only present access to this mine is by a steep zig-zag ascent of 3,000 feet from the Canadian Pacific Railway, at Illecillewaet, and then by a similar descent of 1,000 feet on the other side of the ridge, ore very much richer than the bulk of this appears to be would be required to enable this mine to be profitably worked. The vein has more the appearance of a gash vein than that of a true fissure or fault vein, the slaty rock on either side of the vein being continuous and showing no evidence of vertical displacement. Mr. G. B. Wright gave me a number of specimens from some of the other claims, and those that have been analysed by Mr. Hoffmann, have given from 247·92 oz. to 816·67 oz. of silver to the ton. In one only was a trace of gold found.

The great elevation—from 2,000 to 3,000 feet above the railway—at which most of the present openings are situated, must be considered a somewhat serious disadvantage, but there seems no reason why, by careful and intelligent prospecting, the same veins should not be discovered at lower elevations and in close proximity to the railway. No fossils have yet been found in these slates, but they closely resemble the black graptolitic shales, described by Mr. McConnell, p. 22 D, Annual Report Geological Survey, 1886, and may be of Cambro-Silurian (Ordovician) age.

Samples were procured from the two hot springs at Harrison Lake, British Columbia, and these are now being analysed. That of Banff has also been analysed by Mr. Hoffmann. It will be interesting to ascertain the difference in the mineral contents of these waters—the one rising from the crystalline rocks of the coast range of British Columbia, and the other from the palaeozoic limestones of the Rocky Mountains.

In my last summary report I stated "that the requirements of the Survey in respect to increased museum and office accommodation become each year more pressing." I may now state that, as regards the office accommodation, the steps I recommended are being taken, and in a few weeks four additional well lighted and commodious office rooms will be available. They are on the top flat of the adjoining building which has been connected with the present offices, the communication being closed by double iron doors to minimize the risk of fire, a risk unfortunately always great in the present situation of the Museum, and one which, in view of the great and annually increasing value of the collections, and the impossibility of replacing them if destroyed, merits, I would respectfully submit, the serious consideration of the Government, with a view to its speedy removal.

Dr. G. M. Dawson, with Messrs. R. G. McConnell B. A., and James McEvoy B. Ap. Sc. as assistants, was engaged during the past season in an exploratary survey of the region of the head waters of the Yukon and its vicinity, including portions of the northern part of British Columbia, but for the most part in the territory to the north of the 60th parallel, which constitutes the provincial boundary. Dr. Dawson was placed in general charge of the expedition, which was carried out conjointly by the Geological Survey and Dominion Lands Branches of the Department of the Interior. He furnishes the following preliminary account of the work of the Geological Survey

contingent—Mr. Ogilvie's report on his special work, in connection with the Dominion Lands Branch, appearing elsewhere:—

"The Yukon expedition was undertaken in consequence of the necessity of ascertaining the nature and extent of the developments of placer gold mining, which of late years has attracted an increasing number of miners into the almost unknown district bounded to the south by the northern line of British Columbia, and to the west by the eastern line of Alaska. On account of the remoteness and the isolated character of the region to be examined, and the known difficulties to be encountered in traversing it, much time and attention were devoted to obtaining, by correspondence and otherwise, all available information and in making such preliminary arrangements as were possible. For assistance in these matters, we are specially indebted to Mr. John Grant, M. P. P., of Victoria; to Mr. Robert Campbell, now of Manitoba, the original explorer of a great part of the region; to Mr. J. Wrigley, Commissioner of the Hudson Bay Company, and to Mr. J. McDougall, of the same company.

"I must also express my sense of obligation to Mr. W. Ogilvie, D. L. S., in special charge of the instrumental measurement on the Lewis River and to the 141st meridian, for his ready and obliging co-operation, and to Messrs. R G. McConnell and James McEvoy, of this Survey, for their efficient assistance, to which is due much of the success of the expedition in carrying out the pre-arranged programme of work.

"We left Ottawa on the 22nd of April, travelling by the Canadian Pacific Railway to Victoria, but, in consequence of irregularity in the sailing dates of the Alaskan mail steamers, were unable to reach Wrangell, at the mouth of the Stikine River, where our work may be said to have begun, till the 18th of May. Here Mr. McConnell stayed behind, for the purpose of getting Indians and canoes to enable him to make a micrometer survey of the Stikine from the end of the line measured by Mr. J. Hunter, in 1877, to Telegraph Creek, while I proceeded up the river by the first steamer of the season to Telegraph Creek, the head of navigation. From this place goods are carried by pack animals to Dease Lake, the centre of the Cassiar mining district; and here again a delay of several days occurred, as the animals had not been brought in from their range or shod for the season's work at the date of our arrival. Finally, on June 5th, we reached the head of Dease Lake, and found the greater part of the lake still covered with ice. It was not till the 9th that we were able to reach the point on the shore near Laketon at which two men, previously sent on in advance with an Indian packer, were sawing lumber for boats. Seven days were here busily employed in this work and in constructing three boats for the purposes of the expedition. On the evening of the 16th, a strong wind having broken up the remaining barrier of ice, we reached Laketon with our boats, Mr. McConnell, with a crew of five coast Indians intended for my work on the Upper Liard, having, meanwhile, joined us. On the 18th, having completed our supplies and outfit at Laketon, we left that place, and on the 23rd reached 'Sylvester's lower post' at the confluence of the Dease and Liard Rivers. Here Mr. McConnell with one boat and two men was to separate from us for the purpose of surveying and geologically examining the Lower Liard. In consequence of the delays experienced I thought it advisable to instruct Mr. McConnell to make arrangements, if possible, to winter at Fort Simpson, on the Mackenzie, as this would allow him to spend at least an additional month in exploration in the autumn, besides enabling him to begin work to great advantage next spring, by descending the Mackenzie and crossing by the Rat and Porcupine Rivers to the Yukon, thus obtaining a much more complete knowledge of the geology of the basin of the Upper Yukon than would otherwise be possible. This action on my part I am happy to say has since met with your approval, and advices have been received from Mr. McConnell since my return, to the effect that he had successfully accomplished the work on the Liard and had made arrangements to make his headquarters for the winter at Fort Providence.

"On leaving the confluence of the Dease and Liard, my own party included, besides myself, Mr. McEvoy, Messrs. L. Lewis and D. Johnson, engaged at Victoria, two Tshimsian and three Stikine Indians, all good boatmen. Two local

Indians hired as guides, and to help on the long portage, deserted a day or two after engaging, and from the lower post, to near the confluence of the Pelly and Lewis, for an interval of more than six weeks, we met with neither whites nor Indians.

"The ascent of the Liard and Frances Rivers to Frances Lake proved unexpectedly difficult and tedious, the water being swift throughout and three bad canons having to be passed through. Frances Lake was reached on the 8th of July, and after spending a few days in examining and mapping the lake, making the observations necessary to fix its position, and in the endeavor to find some Indian trail by which we might travel across to the Pelly, we began the work of portaging on the 17th.

"As we had been unable to discover any route now in use by the Indians, and no trace whatever remained of the trail employed by the Hudson Bay Company in former years, and as no local Indians could be found to act as guides or to assist in carrying our stuff, it was evident that the crossing of this portage (which had been estimated by Mr. Campbell at about 70 miles in length) would be a difficult matter, and that we might indeed find it impossible to carry over a sufficient supply of provisions for further work on the Pelly. We therefore, constructed a strong log *cache* on the shore of Frances Lake, and left there, to be taken back to Laketon by the Indians when they returned, everything we could possibly dispense with. Had we been unable to effect the portage, there was in our *cache* an ample supply of provisions to enable the whole party to return to the mouth of the Dease River. After a very toilsome journey, we were, however, so fortunate as to reach the bank of the Pelly on the 29th of July, with still nearly a month's provisions for four persons, the necessary instruments, and a small camping outfit, a canvas cover from which a canoe might be constructed, and the tools and nails for building a wooden boat, should that prove to be necessary. Our Indians, who had for a long time been very uneasy because of their distance from the coast and the unknown character of the country into which they had been taken, were here paid off, and to their great delight allowed to turn back.

"As a dangerous rapid was reported to exist on the upper part of the Pelly, it was decided to construct a canvas canoe in preference to building a boat, which it might prove impossible to portage past the rapid. Having completed the canoe, we descended the Pelly, making a portage of half a mile past Hoole's Rapid or Canon, and reached the confluence of the Lewis branch of the Pelly (or Yukon) on the 11th of August. We had now reached the line of route which is used by the miners and expected to find, at the mouth of the Lewis, a memorandum from Mr. Ogilvie, from whom we had separated in May. As we could not find any such memorandum and as Mr. Ogilvie had not been seen on the lower river by a party of miners whom we met here on their way up the Lewis, we were forced to conclude that he had not yet reached this point. The same party informed us that few miners were during the summer on the Stewart River, where most of the work had been carried on in 1886, but that in consequence of the discovery of "coarse" gold on Forty-mile Creek, about 120 miles further down the river, all had gone there, and that Harper's trading post, where I had hoped to be able to get an additional supply of provisions should we fail to connect with Mr. Ogilvie, had also been moved from the mouth of the Stewart to Forty Mile Creek. From the place where we now were we still had a journey of over 400 miles to the coast with the swift waters of the Lewis to contend against for most of the distance. If, therefore, it should have become necessary to go down stream 220 miles to Forty-mile Creek for provisions, so much would have been added to our up-stream journey that it would become doubtful whether we should be able to afford time for geological work on the Lewis and reach the coast before the smaller lakes near the mountains were frozen over. I therefore decided to set about the building of another boat, suitable for the ascent of the Lewis, and on the second day after we had begun work Mr. Ogilvie very opportunely appeared. After having completed our boat and obtained Mr. Ogilvie's preliminary report and survey sheets, together with the necessary provisions, we began the ascent of the Lewis, from the head waters of which we crossed the mountains by the Chilkoot Pass and reached the coast at the head of

Lynn Canal on 20th September. I am happy to be able to add that the entire expedition was carried out without any serious accident or loss, notwithstanding the difficult nature of the country, and that though circumstantial reports were heard in the spring of trouble between the miners and Indians on the Yukon, these proved to be entirely groundless.

"The geographical, geological and general results of the work are now in process of elaboration and will be made the subject of a detailed report at an early date. Mr. Ogilvie's instrumental survey, now doubtless completed to the intersection of the river with the 141st meridian, will form a sufficiently accurate base line for future explorations in the region. In addition to this, the geographical results include the completion of an instrumental survey of the Stikine to Telegraph Creek by Mr. McConnell, which is connected with Dease Lake by a carefully paced traverse by Mr. McEvoy. Thence, a detailed running survey was carried by the route previously outlined, following the Dease, Liard and Pelly rivers and connecting with Mr. Ogilvie's line at the mouth of the Lewis River, a total distance of about nine hundred miles. Taken in connection with Mr. Ogilvie's measured line, these surveys include an area of over 60,000 square miles, the interior of which is still, with the exception of reports received from a few prospectors and from Indians, a *terra incognita*. The same remark, with little qualification, may be applied to the whole surrounding region outside the surveyed circuit, but much general information has been obtained respecting the entire district which will facilitate further explorations. The whole region is more or less mountainous, though intersected by wide areas of flat or rolling country. The north-eastern margin of the belt of coast mountains may be said to be at Telegraph Creek on the Stikine. A second important mountain range runs in a general north-west by south-east course to the east of Dease Lake and is cut through by the Dease River. To the east of this no high or well-defined range was met with till the vicinity of Frances Lake was reached. Here a range, which may be accepted as the western part of the Rocky Mountains proper, is found with a similar trend to the east, and in this the streams feeding Frances Lake and the Pelly River rise. On the lower Pelly and Lewis Rivers the mountains are less considerable and assume a direction approximating more nearly to east and west.

"The following heights, deduced from a series of observations at a few main points will serve to indicate the general elevation of the country:—

	Feet.
Telegraph Creek, Stikine River (water level)	540
Dease Lake	2,661
Confluence of Dease and Liard Rivers	2,100
Frances Lake	2,577
Pelly River at "Pelly Banks" (water level)	2,965
Old Fort Selkirk, mouth of Lewis River (water level)	1,555
Lake Lindeman, head of Lewis River	2,165

"Till the observations made in the field have been laid down on the map it will be impossible to give with precision any account of the geological features of the region. The rocks in general are closely analogous to those met with in the corresponding region in British Columbia to the south. The coast mountains where crossed by the Stikine and by the Chilkoot Pass consist for the most part of granitoid rocks, with some included crystalline schists precisely similar to those found to the south in the same mountain belt, some details in connection with which are given in my last report on Vancouver Island.†

"To the east of the coast mountains, on the Stikine and Lewis Rivers, there are Palæozoic rocks resembling those provisionally classed in the southern interior parts of British Columbia as the Cache Creek series. They include limestones, quartzites, slates and schists, with a notable proportion of agglomerates and other materials of volcanic origin. In the vicinity of Dease Lake, and nearly on the same line of

† Part B, Annual Report Geol Surv. 1886, V. II.

strike on the Pelly, important beds of serpentine occur, and the associated rocks in these and many other places are preponderantly schistose and slaty, running through numerous varieties, but closely resembling the rocks of the Cariboo and other gold-bearing districts to the south.

"These Palæozoic rocks are by far the most widely spread in the entire region so far as exploration has yet gone, but are interrupted by areas of granitic rocks which generally form ridges or mountain ranges, and these in some places are flanked by more or less important developments of crystalline schists which are probably, at least in part, altered portions of the Palæozoic. The most important granitic range met with in the inland region is that previously mentioned as crossing the Dease River.

"Fossils are by no means abundant in the Palæozoic rocks, but a small collection of graptolites, of Cambro-Silurian age, were obtained on the Dease River, and Carboniferous forms were observed in connection with the limestones in several places. It is quite probable, however, that rocks ranging from the Cambrian to the summit of the Palæozoic, and possibly extending also to the Triassic, may be included in this great series, of which the schistose and slaty members constitute the gold-bearing rocks of the country.

"Rocks which are probably of Cretaceous age occur in limited basins on the Stikine immediately east of the coast mountains, and beds holding Middle or Lower Cretaceous marine fossils have a considerable development on the Lewis River, where there are also plant-bearing beds referable to the horizon of the Laramie and probably of the same age as the so-called Miocene of the Alaskan coast and Mackenzie River. A few fossil plants which are probably Cretaceous in age were also found at one place on the Pelly River.

"The Miocene proper is represented in the Upper Liard valley by soft stratified rocks, associated with basalts, and basaltic overflows, probably of the same age, occur on the Pelly, near the mouth of the Lewis, on the latter river at the Canon, and in the Stickine valley east of the coast mountains. In the last mentioned locality are some remarkable examples of superposed columnar flows overlying coarse gravel deposits. There is not, however, in the entire region examined, any wide basaltic plateau.

"Some features of special scientific interest occur in connection with superficial deposits and the evidences of glacial action, but these cannot be detailed here. It may, however, be stated that in both the Lewis and Pelly valleys traces of heavy glacier-ice moving in northward and north-westward directions, are often apparent. The grooving and furrowing is found equally well marked at the water level, and at the summits of hills several hundred feet in height, and appears to indicate the northward movement of a confluent glacier, in conformity with the general slope of the country. Terraces are of general occurrence and well developed, and often appear at considerable heights on the mountain sides. In connection with the distribution of placer gold, the direction of ice movement in the glacial period is of special importance.

"As the main object of the expedition was the exploration of the Yukon basin, but passing notice could be taken of the Cassiar mining district. The rich placer mines in the vicinity of Dease Lake were discovered in 1872, and reached their maximum productiveness in 1874, in which year they are reported to have yielded about $1,000,000. The yield in succeeding years has gradually declined, but about 150 men are still annually employed in the district. Much prospecting still remains to be accomplished before the possibility of the discovery of new rich creeks is exhausted. Promising deposits of quartz are known to occur, though nothing has yet been done towards their investigation and development. These seem to be worthy of special attention in consequence of the comparative accessibility of the district by means of the Stikine. It would be easy to construct a waggon road from the head of navigation on the river to Dease Lake, and a railway may eventually be expected to follow this route into the interior.

"Gold mining in the Yukon district may be said to have been initiated in 1880,

though little was done in that year except a certain amount of prospecting by twenty-five or thirty miners who entered by way of the Chilkoot Pass. Since then a yearly increasing number of miners have entered the country by the same route, and river bars have been worked with good results on different parts of the Lewis and its tributary the Teslin-too (Newberry of Schwatka, Hootalinqua of the miners), and on the Pelly and Stewart rivers. In 1886 most of the work was done on the Stewart, but in consequence of the discovery of 'heavy' or 'coarse' gold on Forty-mile Creek, as previously mentioned, nearly all the miners went to that place last summer. This is the first discovery of 'coarse' gold in the district, but it may safely be predicted that many more will follow. Prospecting has so far been confined almost exclusively to the larger rivers, and the mining to river-bar mining, but the fact has been developed that gold occurs in greater or less quantity on all the streams, and the extent of the gold-bearing river bars already known is, in the aggregate, almost unprecedented. The number of men engaged in mining on the Upper Yukon last summer was about 250, of which about 100 are wintering in the country. The number likely to be employed next season can only be guessed at, as so much depends on the demand for labor on the west coast generally. It is not impossible, however, that at least 500 men will be at work.

"In comparison with the region now known as an auriferous one on the upper Yukon, the productive portions of the Cassiar mining district are small, as profitable work there was practically confined to a few creeks, yet in 1876 the transit trade at Wrangell, in connection with the mining in Cassiar amounted in value to about a million dollars. This may serve as an index of the probable commercial results of a similar development of placer mining alone in any portion of the Yukon territory.

"The prospective value of the Yukon district and northern part of British Columbia as a mining region I believe to be great. This region includes—measured from the vicinity of Dease Lake to the intersection of the Pelly (Yukon) with the 141st meridian —a length of over 500 miles of the Cordillera belt of the west, which, wherever it has been examined, has been found rich in minerals and particularly in deposits of the precious metals. The width of this particular part of the Cordillera belt is also great, as it appears, so far as our explorations have gone, to extend from the coast to the eastern ranges of the Rocky Mountains in the vicinity of the Mackenzie River. This portion of the Cordillera region, together with that of the more southern part of British Columbia, gives an aggregate length of between 1,200 and 1,300 miles, almost exactly equal to the length of the same metalliferous belt contained by the United States, and in all probability susceptible of an eventual mining development equally great.

"The general climatic features of the region explored and their relation to its orography cannot be entered into in this preliminary note. It must suffice to say that the very humid conditions of the coast do not extend to the interior, which includes some tracts of very dry country, and in the mountains of which glaciers occur rarely, if at all. Wheat, barley and potatoes are grown, on a limited scale, at Telegraph Creek and in its vicinity on the Stikine, though irrigation is necessary. Farther north, summer frosts are probably almost everywhere too frequent to admit of the growth of wheat, but I feel satisfied that barley and rye, with other hardy crops may be grown as far north as the 63rd parallel in the Yukon basin. The country, though generally mountainous in character, includes large tracts of flat or slightly broken land, and is, in fact, one which may eventually support a population as large as that found in corresponding latitudes in Europe (as, for instance, in the province of Vologda in Russia). It is for the most part wooded, and produces much timber of very fair quality, while open hill sides and terraces with bunch grass and aspen thickets occur along the river valleys. Large quantities of fine furs are yearly exported from the Yukon district, reaching the coast by the Chilkat and Chilkoot Passes, Taku and Stikine Rivers, or crossing to the Mackenzie by the Porcupine and Rat Rivers.

"One of the most important features of the Yukon district is the facility which the various large rivers, converging to form the main stream, offer for travel and

inter-communication. These afford means for prospecting and exploring the country, and the distances to which they may respectively be ascended by boat or canoe has not yet, in most cases, been determined. It may be stated, however, that the rivers navigable for sternwheel steamers in Canadian territory have an aggregate length (measured without reference to minor flexures) of considerably over 1,000 miles, in which but one serious break of about three miles occurs on the Lewis. This length will be added to when the upper reaches of the larger streams are examined beyond the rapids or canyons, which are, in the above estimate, considered as defining the head of navigation in each case.

"Over 120 photographs were taken along the route followed, representing the character of the country, and I am happy to say that nearly the whole of these have proved satisfactory on development. Meteorological observations were kept up as regularly as possible, and numerous observations for latitude and longitude were made. Such geological and botanical specimens as appeared to be of interest were brought back, but in consequence of the difficulties of transport the weight of these had to be kept down as much as possible."

Cost of season's exploration of both parties, $4,832.46.

Mr. R. G. McConnell intended to send out a preliminary report on his examination of the lower part of the Liard River, above referred to, by the Hudson Bay winter packet, from Mackenzie River, but as this has failed to arrive in time to be included in this report, the following extracts from letters addressed to Dr. G. M. Dawson may serve to give an outline of his work.

In the first, sent back to the Pacific coast with his men, and dated Liard River, July 27, he writes:—

"I have now got down nearly to the mouth of the Nelson, and have just met some Hudson Bay men ascending the river. I am sending my two men back with them, as the river is good from here, and I can drift down to Fort Liard, even if I cannot find an Indian to go down. I send them back from here because there is no chance of getting supplies either at Fort Liard or Nelson House, and if I took them on to Fort Simpson they could not get back this autumn, as the river is still booming and shows no sign of going down, and we have just about enough food left to last them to their *cache* at the Devil's Portage. I shot two moose on the way down and that kept our supply up. We had a bad time getting down, as the river is a regular cascade for over a hundred miles. Between the Little Canon and forty miles below the Devil's Portage it falls over 1,000 feet, and as forty miles of this is good water you may imagine the state of the rest. It would be bad enough if it had room to flow, but it is penned in by canons, often less than 150 feet wide, every few miles, and then whirls and boils in an incredible manner. We worked our way by sheer muscle, carrying both boat and stuff through forests and over high hills. My men turned out well and worked without a grumble. As for myself, I have hardly a stitch of clothes left, as they were torn to pieces and left hanging on the brambles and roots along the many portages. I hope that you have worked your way through your many difficulties, and have got out to the coast again. But you have a tremendous task before you, which I can appreciate now better than in the spring."

In the next letter, from Fort Smith, Slave River, under date August 23rd, Mr. McConnell writes:—

"After leaving the men I floated down alone as far as Fort Liard, and there got an Indian to take me down in a bark canoe to Fort Simpson. At Fort Simpson I found the steamer, and came up as far as this place in her. This is rather a hard country to winter in without sending in supplies beforehand, as the deer have deserted it, and the people have been on short commons since last march. I am making arrangements to stay at Fort Providence as it is a good locality for fish, and one will always have something to fall back upon. It is, besides, below Slave Lake, the ice on which is the great impediment to getting down the Mackenzie early. * * I am going down Slave River in a canoe, and on the way I will go up Salt River to the ridge in which it heads. From the mouth of Slave River I purpose going up Hay River to the falls, about 100 miles. I may also go up Buffalo River if I have

time. During the winter I will try to visit Horn Hills, and see the country about Fort Rae. I believe Sir J. Richardson is right about the Palæozoic age of the shales between Fort Simpson and this place."

A box of fossils, sent out at the same time with the letter from which the above extracts are taken, has since arrived. The fossils show the presence of Devonian, Triassic and Cretaceous rocks on the Liard River.

Mr. Amos Bowman was occupied the whole season in preparing and in supervising the lithography of the maps of his field work in British Columbia during the seasons of 1885 and 1886, chiefly in the Cariboo district, the survey of which, as stated in my report last year, was undertaken in connection with the Provincial Government. It was then, December 1886, anticipated that the work of reducing the measurements and preparing the maps for publication would have been completed early in 1887. It has, however, together with the preparation of the report on the district, occupied till the close of the year. Both maps and report will be published at an early date.

In Manitoba, Mr. J. B. Tyrrell commenced a geographical and topographical examination and survey of the Riding and Duck Mountain region. He was assisted during the season by Mr. D. B. Dowling. We had very little precise knowledge respecting this district, but were aware of the occurrence in it of salt springs, gypsum deposits and strong indications of petroleum. It was also thought possible that workable seams of coal or lignite and natural gas might be found there, and in view of its proximity to navigable waters and to railways, it was considered important that it should be thoroughly explored. Mr. Tyrrell reports as follows: "We left Ottawa on the 5th July and reached Brandon on the 14th, where the horses used last year on the Calgary and Edmonton survey had previously been brought by rail. Men and supplies having been obtained, the party left Brandon on the 15th of July, following the trail northwards to Strathclair, situated in range 21, township 17. Thence an odometer survey was made up the Little Saskatchewan River, across the Riding Mountains and down the Vermilion River to Lake Dauphin. From the trails, paced surveys were made of the beds of Ochre River and Edward's Creek, the banks of these streams being either too swampy or too much obstructed by fallen timber to admit of following them except on foot.

An odometer survey was then made northward across Wilson River to Valley River, a track survey being at the same time made of the Wilson River and its vicinity. North of Valley River, one of the rounded gravel ridges, known to the Indians as "pitching ridges," was followed first with a buckboard and odometer and afterwards on horseback as far as Fork River, a fairly accurate sketch-map being at the same time made of the eastern face of Duck Mountain. Finding that progress would be very slow north of Fork River, we returned to Valley River and made an odometer survey of the cart trail leading westward along this stream, passing through the gap that separates the Duck from the Riding Mountains in a wide glacial valley leading down into Shell River, from which the trail was followed and surveyed over the high ground southward to the village of Russell, a terminus of one of the branches of the Manitoba and North-Western Railway. From Russell, a similar survey was conducted across Silver, Bird Tail and Arrow Creeks to Shoal Lake, and thence to Little Saskatchewan River, returning by a more northern route to the point of starting. From Russell we proceeded northward with buckboard and carts to Asessippi, on the Shell River, from which point the vehicles were sent round to meet me higher up the river, while with saddle and pack horses I examined the lower part of the valley, and rejoined the carts about the south line of township 26. We then continued up Shell River to within three miles of the confluence of the north and east branches generally in the bottom of the wide deep valley, but sometimes we were obliged to climb to the top of the bank where it was impossible, without great delay, to ford the stream. On the way, however, we left Shell River for a time and turned westward on an

Indian cart trail to Angling Lakes, where Coté's band of Indians have several houses in which they spend the winter, being here in the centre of their hunting grounds. From this village, then quite deserted, a track survey was made of the stream that flows northward out of the largest and most eastern of the Angling Lakes till it flowed into the valley that separates the Duck and Riding Mountains. It was found to be the main branch of Valley River. Two pack trails leading northward from the Indian village were also examined, one being found to lead up the west branch of Valley River to its source, and the other to "The Lake that does not freeze," and the latter of which belongs to the drainage area of Shell River.

Returning to this latter river, we were obliged to leave the carts at a point three miles below the confluence of the north and west branches, and to use pack horses in continuing the survey towards the sources of some of the small streams tributary to the main river. Returning to the carts we followed and surveyed an Indian cart trail northward across Big Boggy and Little Boggy Creeks, till it joined the old Pelly cart trail at the Indian village on Coté's Reserve. We then followed and located the latter trail northward to Fort Pelly, where we arrived on the 22nd of September. Having here obtained sufficient supplies to last till the end of the season, we followed a cart trail to the north-east, keeping north of Swan River for about forty miles, or till we reached the "Square Plain," making an odometer survey throughout the distance. I, however, branched off from this trail, and with pack horses followed a trail up Rolling River, till the stream became very small and was flowing in a shallow valley through a country that appeared to be one interminable swamp. As the country was impassable for horses, I returned and made a paced survey down the bed of the stream to a short distance below the crossing of the old location of the Canadian Pacific Railway, where the river again flows in a defined but winding channel through a marshy level tract of country.

Returning to Square Plain, Swan River was crossed and followed on its northern bank down to the mouth of Oak Creek, where the carts were again left, and with pack and saddle-horses a track survey was made around the north end of Duck Mountain, following, during part of the distance, conspicuous gravel ridges that extend along the eastern face of the escarpment, at least as far north as the valley of Swan River. In returning, the north-east point of the Duck Mountain was crossed, and also the head-waters of North and South Duck Rivers and Pine River. Then passing around the north end of Big Lake, in which Rolling River takes its risé, the head of Favell River was reached. This river was then followed on a northward course to near its junction with Rolling River, returning thence to the carts at the mouth of Oak Creek.

While I was engaged as above described, Mr. Dowling was making pace and track surveys of Swan River and of the country lying north of it in the vicinity of the camp.

Below Oak Creek an odometer survey was made of the trail down to Swan Lake, and the river was followed on foot in many places, where there was any possibility of exposures of the underlying rocks being met with. From Swan Lake the party returned to Fort Pelly by the old Hudson Bay Company's cart trail on the north side of Swan River, at the same time making an examination of the southern face of Thunder Hill.

The village of Russell was reached and the season's work completed on the 7th of November. Arrangements were made for the care of the horses and outfit for the winter before leaving for Ottawa, which we reached on the 14th November.

The surveys, which were checked throughout by latitudes taken with an eight inch sextant, will be plotted at once, and material will thus be furnished for an approximately correct map of a part of the country that, up to the present, has been almost entirely unknown.

Readings were taken regularly three times a day from a mercurial barometer, and numerous intermediate readings were taken from two aneroids, and as these will be compared with readings taken from a standard mercurial at Minnedosa, the height of which is known, it is hoped that the altitude of all important points can be de-

termined with sufficient exactness to show the general slope of the country and the height of most of the important elevations.

The geological structure of these so-called mountains, as far as seen, is very simple. They are composed of practically horizontal dark-grey clay-shale, interbedded with bands of chalky limestone and bands and nodules of hard sandstone. These beds contain fossils characteristic of the Niobrara and Benton subdivisions of the Cretaceous of Meek and Hayden's Nebraska section, and it is not improbable that some of the lower beds, which on the Swan River were found to be sandstones and clays, represent their lowest, or Dakota, Group, but no fossils were found to corroborate this, and no break or unconformity of any kind was found between any of the beds

In some places, as on Vermilion and Ochre Rivers, the dark shales were found to contain a small quantity of mineral oil, and it is quite possible that borings may reveal reservoirs holding this oil in considerable quantities. No coal seams of any value, though carefully sought for, were found.

This subject and the geological structure of the district will be treated of in a detailed report to be prepared during the winter, after the observations and collections have been studied and the measurements plotted. About 1200 lineal miles of survey were made, and the observations covered an area of 3200 square miles of territory within the province of Manitoba.

The surface of the country is almost everywhere underlain by an irregular deposit of till, varying from a very thin crust to a massive bed several hundred feet in thickness. East of Duck Mountain its surface on the lower lands is generally level or lightly sloping, to the west it is generally more or less undulating, while on the summit of the mountain, and on the upper parts of its eastern slope there are many areas covered by moranic ridges, consisting of high drift knolls, thickly overstrewn with gneissoid boulders, between which are deep rounded hollows, often holding small lakes of beautifully clear water.

Most of this latter country is practically valueless for agriculture, but considerable areas of it are covered with valuable forests, which by careful cutting could be made to yield a continuous supply of timber; but much of this rough land, especially that towards the north, is so thickly covered with boulders that it appears unable to bear more than a few scattered and stunted scrub pines. The undulating land to the south and west of the Duck and Riding Mountains is at present partly covered with groves of poplar, between which are more or less extensive areas of grassy prairie. This country is admirably suited for agriculture, since the soil is rich and well drained, and wheat can be raised with very little danger from early frost, certainly as far north as Big Boggy Creek, and perhaps as far as Fort Pelly. But perhaps the most fertile part of the whole district is that which lies between Dauphin Lake and the foot of Riding Mountain, where the underlying till is covered with rich layers of alluvial sand and clay. The land slopes gently towards the lake and is drained by several clear streams that flow from the face of the mountains. The area is partly wooded, the surface being covered with a rank growth of grass, weeds and rose bushes, and dotted with groves of willow and poplar. Towards the north it is continuous with the swampy country lying between the gravel ridges east of Duck Mountain, though even here there are many rich meadows. Still further north, in the Swan River valley, meadow land again forms the greater portion of the surface, bearing a close growth of tall fine grass.

Near the headwaters of the Shell and Valley Rivers, between Rolling and Favell rivers, on the northern face of Duck Mountain, as well as on some of the streams flowing from its eastern slope, there are some large areas covered with excellent white spruce averaging from 10 to 20 inches in diameter. Much of that on Shell River can be floated down into the Assiniboine River, where it can be sawn and distributed, but the rest must be floated into Lake Winnipegoosis. From there it must be conveyed to Lake Manitoba before it can reach a market, but this will be a very easy matter when communication is once opened through the narrow neck of land in the vicinity of Meadow Portage. Of late years fires have been doing very great damage to the forests of this region, and it certainly seems advisable

that some more stringent measures should be adopted to prevent the occurrence of the conflagrations that periodically sweep over such large areas throughout northern Manitoba.

Fossils were collected from the Cretaceous shales and limestones, and also a small but interesting collection was obtained from beds of pre-glacial or en-glacial age, near the summit of Duck Mountain. Numerous specimens of recent mammals, birds and insects were also collected.

Fifty-six photographs were taken during the season illustrative of the geology and general surface features of the country examined.

Cost of exploration, $1,741.16.

In April correspondence was entered into with Major Powell, director of the United States Geological Survey, with a view to joint action in carrying out the survey and delineation of the glacial Lake Agassiz in its continuation into Manitoba. The terms of this joint action were agreed upon, and on the 6th May Major Powell wrote expressing his "gratification at this inauguration of international work."

On the 11th September, Mr. Warren Upham, to whom the work was entrusted by Major Powell, wrote as follows:—"I have the honor to report the successful completion of the examination of the glacial Lake Agassiz in its continuation north of the international boundary in Manitoba, done under the auspices of your survey jointly for a detailed report to be made by me to you during the coming winter, and for my monograph on the subject for the United States Geological Survey. The cost of this exploration was $344.88."

Mr. Upham's report will form part of the next Annual Report.

Mr. A. Lawson left Ottawa for the field accompanied by Mr. Smith as assistant on the 27th of May, to continue the exploration and survey of the country between the Lake of the Woods, Rainy Lake and Lake Superior.

The work was commenced in the vicinity of Rainy Lake, and during the months of June, July and August Messrs. Lawson and Smith were occupied in making the surveys and investigations necessary to complete the maps of the Rainy Lake and the Rainy River districts. These maps cover an area of 5,182 square miles. They will be similar to that of the Lake of the Woods, published with Part c. c., of the Annual Report, 1885, though on the smaller scale of four miles to one inch. The information for these maps is now in course of compilation in the office and the maps will be prepared for publication, together with a detailed report during the winter.

After completing the field work, and before commencing the survey of the intervening country east of Rainy Lake, it was deemed desirable to make a further general reconnaisance of the geological features of the Thunder Bay district and the vicinity of Port Arthur, where latterly mining interests have been rapidly developing. The remainder of the season was accordingly devoted to this work and to a visit to the Vermilion Lake and Gogebic iron ore districts in Minnesota for the purpose of comparing the geological conditions which obtain there in connection with these deposits, with those of the Thunder Bay district, in many parts of which there are geological indications inducing the belief that valuable deposits of iron ore exist there like those above referred to. While Mr. Lawson was thus engaged Mr. Smith continued the topographical work on the north side of Hunter's Island in the vicinity of the international boundary.

Mr. Lawson's party was in the field four and a half months. Average strength five men. About 700 miles were measured by micrometer, log survey and compass triangulation.

Cost of exploration, $1,608.97.

Mr. A. P. Low, accompanied by Mr. J. M. Macoun as assistant, was engaged during the summer in making an exploration of the islands of James Bay. No suitable craft for the work could be obtained at Moose Factory. A Lake Huron fishing boat was therefore purchased at Collingwood and sent to Missinabie station, on the

Canadian Pacific Railway, situated on Dog Lake, at the head of the Michipocoten River. From here the boat was taken across the height of land and down the Missinabie branch of the Moose River to James' Bay, Moose Factory being reached 27th June. Leaving Moose 2nd July, the first island visited, called Charlton, lies near the southern end of the bay and about one-third of the distance across from the eastern shore. This island was found to be wholly made up of sand, clay and boulders, without any rock in place, and further investigation on the other islands visited showed that they were all of the same drift origin. Charlton Island is the second island in James' Bay in regard to size, being in shape an irregular oblique parallelogram, the diagonals being 18 miles from N.E. to S.W., and 12 miles from N.W. to S.E.

On the south side the shores are low and swampy, covered with a dense growth of black spruce and tamarac of small size; on the other sides the shores are high, and inland the island is a rolling plateau, with a light sandy soil, supporting a larger growth of white spruce and poplar. While on Charlton Island a paced survey was made on the shore of Danby Island, which lies about one mile to the eastward. It was found to be roughly triangular in shape, each side being about two miles long. The whole island is low and flat and covered with small black spruce and tamarac. On 11th July the party crossed to the Strattons, two small islands lying N. 65° E. from the north-east point of Charlton and ten miles distant. The western or larger is five miles long from E. to W. by about one mile and a half broad; the smaller is nearly round, with a diameter of one mile and a half. The interior of the larger island has an elevation of seventy-five feet above sea level.

Little Charlton Island was next visited, distant eighteen miles from the Strattons in a N.N.W. direction.

From Little Charlton a northerly course was taken through the Tiders, several small low islands, the larger covered with low bushes, the smaller being merely sand and boulder shoals, stopping at Watson Island which lies N. 33 E. from Little Charlton in latitude 52° 31·07".

This island in form resembles a thin crescent, the greatest length being eight miles from north to south. With the exception of a few stunted white spruce, no trees grow on the island, its sand and boulder surface being covered with small arctic flowering plants, grasses and sedges. Continuing northward, Solomon's Temples, a number of low, sandy shoals were passed, and the Twins, two large islands lying north and south and separated by a channel five miles wide were reached. These islands have the same barren character as Watson. After the Twins, Walter and Spencer small islands lying to the eastward were examined and the mouth of the Big River reached 19th July. Here the party divided, Mr. Low going up the river while Mr. Macoun explored the Lead and Bear Islands to the northward. The Big River was ascended fifty miles in an easterly direction. This is the largest river flowing into the east side of Hudson Bay and is navigable with large boats for twenty miles from its mouth. It flows in a valley from one-third to one mile wide between cut banks from thirty to one hundred feet high.

The surrounding country is covered with a dense growth of trees in the following order as regards quantity: black and white spruce, tamarac, balsam and aspen poplar, balsam spruce and banksian pine; there are numerous outcrops of rock along the shores, the most common being a dark grey hornblende-gneiss.

Leaving Fort George, 2nd August, the bay was crossed by way of the Twins and the Island of Agoomski reached.

This is the largest island in James' Bay, being about seventy miles long from N. W. to S. E. by an average of ten miles broad.

Unlike the other islands, its coast line and interior are low and swampy and the interior is covered with small spruce and tamarac. From Agoomski the party returned to Moose Factory and thence by the Missinabie River reached the Canadian Pacific Railway 7th September.

The coast line and islands as laid down on the Admiralty chart do not agree with the Hudson Bay Company's chart, especially on the east coast, and further, neither

the size, shape or position of the islands visited by Mr. Low agrees closely with that given on either of the charts.

Mr. Macoun made several interesting additions to the collections of plants and insects.

Total cost of the exploration, $3,179.00.

In December last Mr. E. D. Ingall visited the salt districts of Ontario for the purpose of investigating the present condition of that industry, and to gather statistics and other information relating to it. This work was continued by means of correspondence, after his return to Ottawa on the 5th of January. He was then engaged completing a report on the subject, and also one on the silver production of Canada, both of which are published in the Statistical Report on mineral production in Canada, Part S, of the annual volume for 1886.

The preparation of the latter report, examinations for which were commenced in 1885, was much delayed last year by the preliminary work with Mr. Coste in connection with the arrangements for the collection of the mining and mineral statistics.

After the completion of this work, Mr. Ingall commenced the preparation of the maps and other illustrations to accompany his report on the silver mining district west of Port Arthur, and on the geological features connected with the very rich silver bearing veins of that district. At the same time arrangements were being made to commence an exhaustive investigation and survey during the approaching summer of the apatite mining districts in Ottawa county, province of Quebec with a view to the preparation of a monograph on the apatite deposits and their developments.

In pursuance of this plan it was decided to make an accurate delineation of the rocks associated with these deposits over an area of about 200 square miles, so outlined as to embrace the most important mines of the district, thus including parts of the townships of Portland, Derry, Buckingham, and Templeton. Mr. Ingall was assisted by Mr. J. White, who on the 22nd June commenced the preliminary topographical measurements, requisite for the construction of a map on which to lay down the geological features and the position of the worked and the unworked apatite deposits. At the same time Mr. Ingall made a tour of inspection of the principal mines, and then returned to Ottawa to continue work in connection with his report on the silver bearing district above referred to, leaving Mr. White to continue the work in the field. This was unfortunately brought to a close on the 11th of August by a serious accident, in which Mr. White had his leg broken and was otherwise so seriously injured as to incapacitate him for any work during the rest of the season. Under these circumstances, Mr. Ingall disbanded the party and has since devoted his time to the completion of his monograph of the Thunder Bay, Lake Superior silver mines, of which the publication is now in progress.

Cost of the work in the field, $860.24

Dr. R. Bell was engaged during the summer in an exploration of a portion of the large tract of but little known country on the confines of the provinces of Quebec and Ontario, including Lakes Temiscaming and Abbittibbi, the Montreal River and the upper waters of the Ottawa. The chief objects of the exploration were to ascertain more precisely the northern extension and the distribution of the great mineral bearing belt of Huronian rocks which commences on the Georgian Bay of Lake Huron and crosses the Canadian Pacific Railway at and in the vicinity of Sudbury, also to investigate the question of the northern limit of the apatite or phosphate and mica bearing belts of Ottawa county, and likewise to make such additions as might be possible to the existing very imperfect geographical knowledge of the region to be traversed.

Dr. Bell was assisted in the field during the summer by Messrs. A. E. Barlow and A. S. Cochrane, by the former from the 16th July to the 1st October and by the latter from 8th September to the 28th of October. The exploration extended from the 11th July to the 18th of October, when Dr. Bell returned to Ottawa.

Dr. Bell furnishes the following summary of the season's operations :—

"Although the watershed to Hudson Bay was crossed both in the eastern and in the western extension of the exploration, the country examined may be described as the Upper Ottawa country, as the waters used as the bases of our operations, both east and west of Lake Temiscaming, fall into the Ottawa River.

"Fort Temiscaming was selected as headquarters for the summer."

The examination of the rocks of Lake Temiscaming was in continuation of the work of Sir W. E. Logan, in 1845, the result of which is summarized in Chapters IV and XII of the Geology of Canada, 1863, and where also the succession of the Laurentian and the Huronian rocks on Lake Temiscaming is described. In the report for 1845 the rocks are more fully described, but they were not then known as Laurentian and Huronian.

Dr. Bell now states :—"This lake is surrounded by Huronian rocks and these were re-examined in the light of the knowledge of the Huronian system which has been gained since the time of Sir W. Logan's visit in 1845. The Silurian limestones, &c., of the islands and of the northern part of the lake were also examined and a considerable collection of their fossils was made. It is believed that the limits of the Silurian area at the north end of the lake can now be defined with tolerable accuracy.

"The course of the main Montreal River is singularly straight; its upward bearing is about north-west and the distance from the mouth to the Great Bend, near which it divides into two branches flowing from the south, is 85 miles in a straight line. In 1875 I examined both these branches and the country thence to Lake Mattagami, in connection with a geological exploration, extending from the Wanapitai and Sturgeon Rivers, but the main Montreal River, below the Bend, had not hitherto been examined geologically. The rocks along it were found to belong to the Huronian system, except in two parts, namely at Bass Creek, two miles above the head of Elk Lake and just below the extremity of Sinclair's Line, or four miles below the junction of the East Branch, where Laurentian gneiss was met with.

"From the Great Bend of the Montreal River I crossed the height of land northward and descended the Frederick House River, a branch of the Abittibbi, to Paishko-tchagami Lake. All the rocks seen on this route also belong to the Huronian.

"On returning from this exploration I descended the Montreal River to its junction with the northern outlet of Temagami Lake and made a track-survey and geological examination of the lakes through which it flows. The rocks on this route were found to consist principally of clay-slates, argillites and quartzites. At the time of my visit to Temagami Lake Mr. Barlow was engaged in making a micrometer and compass survey of it, having begun this work on the 23rd July, and he completed it about the end of September, after which he made a similar survey of the route from Temagami Lake *vid* Rabbit Lake to the foot of Lake Temiscaming. Temagami Lake was found to measure about thirty miles in its greatest extent, or from north to south, and nearly the same from east to west, but much of its general area is occupied by peninsulas and islands. It is remarkable for having two outlets which discharge its waters the one into the St. Lawrence and the other into the Ottawa. The southern outlet is a branch of the Sturgeon River, which flows into Lake Nipissing and thence by the French River into Lake Huron; while the northern outlet as already mentioned, falls into the Montreal River and thence into the Ottawa. The rocks around Temagami Lake embrace felsites holding pebbles of syenite, which are the most abundant, quartzites, clay-slates, massive diorites and crystalline schists.

"After having made a geological reconnaisance of Temagami Lake, I returned to Fort Temiscaming by way of Rabbit Lake and the Mattabaichawan River and found the rocks along this route to consist principally of felsites and clay-slates.

"The Rivière Blanche and the travelled canoe route from Lake Temiscaming to Abittibi Lake were explored geologically by the late Mr. Walter McOuat in 1872,* and during the present year Mr. E. B. Borron, on behalf of the Government of Ontario, made an exploration of the region lying to the southward of the latter lake

* Report of Progress. Geol. Sur., 1872-73 pp. 112-135.

and he has kindly promised to furnish me with notes of his geological observations. We are indebted to Mr. Edward Haycock and to Mr. David Beatty, P.L.S., for additional information on the rocks of the Rivière Blanche and neighborhood.

"The next division of the season's operations consisted of the exploration of the region between Lake Temiscaming and the source of the Ottawa. Accompanied by Mr. Cochrane I proceeded from this lake by way of Kippewa, Birch, Sasiganaga, Wolf and Grassy Lakes to the Grand Lac du Moine, and thence to Grand or Victoria Lake of the Ottawa. Laurentian gneiss was the only rock observed on this route all the way from the foot of Lake Temiscaming.

"From Grand Lake Mr. Cochrane was sent northward to ascertain whether or not the Huronian belt which crosses the canoe-route between the height-of-land and Lake Abbittibbi, extends eastwardly to that longitude. In connection with this exploration he made a track survey of the northern arm of Grand Lake, which has a length of about twenty miles, and thence across the watershed, and down the chain of lakes and streams which leads in the same direction to Shabogamog Lake. A track-survey and a geological examination were made of this lake, which proved to be over thirty miles long. Mr. Cochrane next descended the river flowing from this Shabogamog Lake for a distance of over ten miles, northwardly, where a series of rapids begins. It proved to be a large stream, fully equal to the Ottawa just below Grand Lake, and is apparently the head of the un-named river flowing into Hannah Bay, at the southern extremity of James' Bay. The height-of land passes close to the northern extremity of Grand Lake, and soon after crossing it Mr. Cochrane found crystalline schists of the Huronian system, and further on they were met with here and there, alternating with Laurentian-like gneiss, as far as the outlet of Shabogamog Lake, beyond which the schists were continuous as far as he descended the river. There is little doubt these rocks form part of the Huronian belt, extending eastward from Abbittibbi Lake.

"On returning to Grand Lake Mr. Cochrane, according to instructions, descended the Ottawa to Lake Temiscaming. The section of the river lying between Grand Lake and Lac des Quinze had been surveyed with the micrometer by Mr. Lindsay Russell, and it only remained for Mr. Cochrane to note the geological formations. The rocks along this division of the Ottawa proved to consist entirely of Laurentian gneiss. The Huronian schists, between Lac des Quinze and Lake Temiscaming were examined and reported on by the late Mr. McOuat, in 1872.

"Leaving Mr. Cochrane at Grand Lake to continue the explorations which have just been described, I proceeded up stream towards the source of the Ottawa. Grand Lake, the Ottawa River and the lakes upon its course as far as Barrier Lake, had been explored by Mr. Henry C. Symmes, P. L. S., in 1866, so that I only required to examine this section geologically, and throughout its whole extent the only rocks seen were gneiss.

"Above Barrier Lake, both a geological examination and a track-survey of the Ottawa were made to its source, which was found to be in a small lake at the head of the north-western and longest of the two branches into which it ultimately divides. This sheet of water, which is only about two miles long, had no name, and I called it Ottawa Lake, as an appropriate designation, and as following the almost universal rule which obtains in these regions by which the lake at the source of a river bears the same name as the river flowing from it. Laurentian gneiss continued to be the only rock observed all the way from Barrier Lake to Ottawa Lake.

"From Ottawa Lake I crossed the water-shed to Echaume Lake, one of the sources of the Gatineau River, and then descended that stream, which is constantly augmented by tributaries from either side as far as the river Désert, continuing to make both a track-survey and a geological examination the whole way. No rock but gneiss was met with in descending the Gatineau until reaching a portage about thirty miles below the Zigonse or principal north-east tributary of the river, where a white-weathering coarsely crystalline light grey limestone made its appearance, and was afterwards traced, almost continuously, down the river nearly to its mouth. This well characterized belt of limestone has evidently a great thickness. Thinner bands of a somewhat similar crystalline limestone were observed interstratifying gneisses, &c., in the lower part of the valley of the Désert. From this point I brought

my canoe-men by stage to Ottawa, and thence sent them back to Lake Temiscaming *vid* Mattawa."

The limestone above referred to by Dr. Bell was first noticed by Mr. J. Richardson in 1870 and is pretty fully described by him in the Report of Progress, Geol. Survey 1870-71, in which, on page 289, he says: "Without further examination it would be impossible to say whether these limestones which are so largely displayed along this portion of the Gatineau River form one or more bands. The thickness of this limestone in some parts cannot be short of five or six hundred feet and below the Big Eddy Portage may reach a thousand feet."

Dr. Bell further reports that while endeavoring to ascertain the nature, structure and geographical distribution of the rocks in the districts examined during the season, special attention was directed to the discovery of economic minerals.

"In this connection it may be mentioned that some days were devoted to an enquiry and examination into the alleged discovery of auriferous quartz veins in several places in the vicinity of Mattawa. The various openings where the discoveries were said to have been made were visited and a number of specimens were collected. These have since been assayed by Mr. Hoffmann, but without finding gold or silver in any of them.

"The glaciation of the fundamental rocks and other phenomena of the drift were studied and many interesting facts noted, but these will be more appropriately recorded in the detailed report to be prepared. Numerous observations for latitude were made, which will be used to give greater accuracy to the maps of our track surveys. Notes were constantly kept in reference to commercial timber and to the distribution and the northern limits of the trees in the region visited. Considerable information was gathered on the natural history of the districts, especially with reference to food fishes; and collections of Coleoptera and Lepidoptera were made. The temperature of Lake Temagamin and of other lakes was recorded three times a day by Mr. J. Fraser, a member of the party.

"Forty photographic views were taken to illustrate the various characteristic features of the scenery, points of geological interest and the general aspect of the country.

"As on all previous occasions the Survey is again indebted to the officers of the Hudson's Bay Company for their kind hospitality and assistance in promoting the work, and in this connection I may be allowed to mention more particularly Chief Factor Colin Rankin, Mr. C. C. Farr, J.P., Mr. J. Mann, Mr. L. Christopherson and Mr. J. Turner.

Cost of season's exploration, $2,036.87.

Mr. F. D. Adams left Ottawa on the 13th July, and spent the following three months and a-half in exploring and mapping in detail those portions of the counties of Montcalm and Joliette, which are included in the north-west quarter sheet of the map known as the map of the Eastern Townships.

The area examined by Mr. Adams has an extent of about 1,200 square miles, and lies immediately to the north of that explored by him in 1885. He now states that,

"The great mass of anorthosite underlying Morin, Abercrombie, Wexford and several other townships in Montcalm and in the adjacent counties, and the southern and western boundaries of which have already been determined, was still further examined, and its southern and eastern boundaries carefully traced. In doing so the unexpected fact was ascertained that the so-called massive and stratified varieties of this rock are in reality only different portions of one and the same mass. A number of small outliers of anorthosite were found in the gneiss to the east of this main area, resembling those found before on its western and southern sides. Four bands of crystalline limestone were also found east of the Lac Ouarreau band and on the eastern side of the principal anorthosite area, some of which undoubtedly correspond to those found by Sir William Logan on its western side. As a result of this summer's work, I think it may be safely concluded that the rocks comprising the principal area of anorthosite above referred to, as well as most, if not all, of the smaller areas, are of eruptive origin.

"All localities, where minerals of economic importance were reported to occur, were visited and examined. These were for the most part deposits supposed to contain either gold or iron ore, many of which are associated with bands of pyritous rock near the contact of the anorthosite and gneiss. Several of them, now abandoned, had at one time been more or less extensively worked for gold. Specimens of these ores were collected, and it is proposed to assay them, in order to ascertain whether they really contain a sufficient amount of gold to warrant further efforts being made for their development. A large number of other specimens were also collected, some of which, it is hoped, may prove of economic importance, as well as of scientific interest.

"There still remains a large area to be examined within the limits of the map referred to, and until this is effected and the map can be completed for publication, it is deemed desirable to defer the preparation of a detailed report on the geological structure of the district. A short report will, however, be prepared during this winter, dealing chiefly with the economic resources of those portions already examined, and which seem to be of more immediate practical importance.

Cost of season's exploration, $563.00.

Dr. R. W. Ells, with Mr. N. J. Giroux as assistant, was occupied during the past season in continuing to the north-east the final examination and mapping of the geological formations on the south side of the St. Lawrence, in a part of the area comprising the north-east quarter sheet of the map of the Eastern Townships, extending from the county of Megantic north-eastward to the county of L'Islet. This work was, as stated, a continuation of that of the previous season to the south, which is described in the summary report for 1886, and in greater detail in part J of the annual report recently issued. The first two months were devoted principally to an examination of the gold-bearing rocks of the Chaudière district, and later the rocks along the southern side of the St. Lawrence were re-examined from St. Nicholas towards Rivière du Loup, together with some of the islands below the Island of Orleans. The object of this was to ascertain and to map more accurately than has been hitherto effected the distribution and the relative positions of the Levis formation and of the so-called Lauzon and Sillery formations along the borders of the St. Lawrence, where the rocks over considerable areas, were in 1869 assigned to the horizon of the Potsdam sandstone, while other large areas of precisely similar rocks were still included in one or other of the sub-divisions of the so-called Quebec group. The reconnaisance examinations which I have, from time to time, carried out in all parts of the region since 1874 had made it evident that an entire revision of the work of 1869 and previous years was now required, and this was commenced by Dr. Ells in 1885, and has since been ably prosecuted by him. The observations of the past season must now be carefully studied, and another season's work in the area will be required before the actual distribution of the formations can be fully ascertained and finally mapped, and the geological structure reported on, as there is still a very large area, probably not less than 1,250 square miles, in the counties of Bellechasse, Montmagny and L'Islet, that has been but little, if at all, explored. Much of it is thickly wooded and difficult of access; but as it is on the line of strike of the mineral-bearing belt to the south-west, it is not impossible that in some parts of it there may be a recurrence either of the asbestos, the iron ore, or the cupriferous deposits of that belt. In any case it is very desirable that the whole area should now be fully and exhaustively explored, and its geological structure worked out before the map of it is published. This, it is hoped, may be accomplished next year. A number of outcrops of serpentine, which are confined to the area south-west of the Etchemin River, were examined, with a view to finding workable deposits of asbestos, but though at several of these small veins of asbestos were observed, the mineral does not appear to occur in sufficient quantity to be of economic importance, and the altered igneous rocks with which it is associated to the south-west, chiefly in what has been called the volcanic belt, seem to disappear after the valleys of the Chaudière and Etchemin rivers are crossed.

On mining in the district Dr. Ells reports:—

"The output of asbestos at the mines of Coleraine and Thetford has largely increased during the past season, and preparations were being made to continue working during the winter. Several new mines have been opened at Thetford and near the Coleraine station, which promise well.

"The Broughton Mine, situated on lot 14, range 7, Broughton, about half a mile west of the Quebec Central railway, is still being worked, though its present output is not very considerable. The asbestos at this mine occurs in an irregular vein along the contact between the serpentine and the black Cambrian slates, and differs from that obtained at the other mines of this mineral in character of fibre, and in its being associated with soapstone. It is, in so far as yet ascertained, confined to but one vein of any importance. Three shafts have been sunk in the line of outcrop, and some very excellent asbestos has been extracted, more especially from the upper portion of the vein. Very good indications of asbestos were also observed on lots 27, 28 and 29, range A, Coleraine, near the Poudrier road, the property of Dr. James Reed. Though but little work had been done, a number of veins of asbestos were exposed at the surface, varying in thickness from half an inch to an inch and a half.

"The gold mines of the Chaudière have not yet been developed on a scale commensurate with their importance. During the past season three companies have been engaged in mining operations, viz., the St. Onge Co, on Slate Creek, at St. George, Beauce; Messrs. Coupal & McArthur, on Mill Creek, near St. Francis village, and Capt. Richards on the Cumberland Stream, a branch of the Famine River. On the DesPlantes River also, Mr. Horace Sewell has been engaged in prospecting, with the object of finding the old channel of that stream, and claims to have been successful in locating it, though no work has yet been done to test it as a source of gold. At St. Francis, Mr. Coupal states that he has found considerable "coarse" gold.

"During the past summer the old copper mine at Harvey Hill has again been opened up, under the management of Mr. Chas. Lionais, but at the time of my visit the operations were confined principally to repairing the shafts and buildings. This mine has already been fully described in the Geology of Canada, 1863, pp. 724, 728, and no further information need here be given concerning it.

"Work has again been resumed at the South Ham antimony mine. This property is mentioned in the Geology of Canada, 1863, p. 876, and later in the Report of Progress Geo. Survey 1881-82, p. 399. It has lately changed hands, and is now owned by Dr. James Reed, who within the present year, 1887, has driven a tunnel from the lower part of the hill in which the mine is situated, a distance of 304 feet, which has struck the vein at the bottom of the 100 foot shaft, with which also the other workings of the mine are connected. The mineral bearing lode, cut by the tunnel, is reported by Dr. Reed to be seventy feet in width, all of which he says will pay for extraction. The object of the tunnel driven by Dr. Reed is to drain the workings and to facilitate the extraction of the ore. Dr. Reed has already taken out about twenty tons of ore, and intends carrying on the work during the winter. The great difficulty in the way at present is the lack of a market, a difficulty likewise experienced at the antimony mines of Nova Scotia and New Brunswick. According to the "Mineral Resources of the United States, 1885," the price of 50 per cent. ore was at that date $10 per ton, the amount of crude antimony and regulus imported into the United States for that year, being 2,668,302 lbs., valued at $223,741, and of antimony ore 243,635 lbs., valued at $8,783.

"Attention has again been directed to the iron ore deposits of Leeds. These ores, referred to in the Geology of Canada, 1863, p. 677, were subsequently examined by the late Mr. Chas. Robb, M.E., and are also referred to in "Iron Ores of Canada, p. 205, Rep. Geol. Sur., 1873-74," by Dr. Harrington, who says: "The strata have been exposed by stripping for a distance of forty yards in the direction of the strike, and sixteen yards across it. In the latter distance three tolerably regular beds of ore were seen, respectively six, four and three feet thick, and all dipping to the north-west at an angle of 50°. The beds are separated by bands of chloritic slate, containing quartz and felspar. The ore is a fine-grained magnetite, more or less mixed with micaceous

iron ore, and some specimens exhibit polarity in a marked manner." Similar ores occur in the adjoining township of Inverness. The analysis of the Leeds ore, by Dr. Harrington, gave: metallic iron, 67 079; phos., ·206; sulphur, ·038. These ores are distant from the Quebec Central railway, at Robinson station, about ten miles, and from the Grand Trunk railway, at Bécancour station, from sixteen to eighteen miles.

The field work was commenced on the 4th of June, and terminated on the 19th October—cost $1,449.33.

Professor Laflamme, who was engaged for a short time during the summer in re-examining the country and in continuing the revision of the geological boundaries on the north side of the St. Lawrence above Quebec, furnishes the following report:—

"A detailed examination was made of the country between the St. Maurice and the Batiscan Rivers, especially that portion of it which lies to the north of the boundary of the Cambro-Silurian rocks. The rocks observed here, as everywhere else in this region, belong to the Laurentian gneiss, which occurs in all its varieties. I, however, observed also three important bands of crystalline limestone in the parish of St. Tite. One commences at the southern extremity of Lake Roberge and runs westward to Lake Claire where it terminates. It is a coarse-grained limestone and encloses many fragments of gneiss, occurring as angular blocks regularly distributed through the limestone. The exposure is about five or six hundred feet wide, and about half a mile in length. The stone could, probably, only be utilized for burning into lime.

"The second band occurs about six miles to the south-east of the first. It is a fine-grained rose colored limestone, susceptible of taking a fine polish and consequently of being used as an ornamental marble. At the junction of the limestone and gneiss there is a distinct appearance of bedding or alternating bands of limestone and of gneiss dipping south easterly 75°. The exposure is about two acres in extent.

"The third band occurs about a mile to the south of the second, and the limestone closely resembles that of the Lake Roberge band, the crystals perhaps even larger. It likewise encloses many angular fragments of the surrounding rock. It could not be utilized as a marble.

All this northern country closely resembles the Saguenay district in the manner in which the deposits of clay "glaise," occur. These deposits are very irregular and show much false bedding in most of the section made by the railway. There is no trace of quaternary fossils like those of the country in the vicinity of Quebec, and it seems that these deposits are all the result of the submergence of this part of the country by the fresh waters of the melting ice and snow of the glacial epoch. The country is generally fertile, but there is a larger number of extensive projections of Laurentian rocks, which interrupt the continuity of the clay deposits.

"East of Batiscan River the Laurentian rocks present the same general character as do also the arable lands. The general strike is north-east and south-west, and there is no trace of limestone bands in this region.

"I also made a further geological examination on the St. Anne River, but have nothing to add to what was stated last year.

"The Trenton limestones are very regular with a scarcely discernable dip to south-south-east. About two miles above St. Anne's church they are covered by the Utica and Hudson River formations.

"In conclusion, I desire to draw attention to the work now being done in this part of the country in connection with the occurrence of natural gas.

"Already a number of wells have been bored, and though the result has not been what was at first anticipated, yet there is no reason why judiciously conducted researches should not some day be crowned with success. The discovery of natural gas in available quantity in the province of Quebec would be extremely valuable. We have no coal to work our minerals. Natural gas might replace it and give

fresh impulse to all our industries. Abundant sources of natural gas have been found in Ohio in the same formations, adding a certain degree of probability to the presence of gas in our Trenton and Utica formations."

Cost of explorations, $400.

From the above it might, perhaps, be inferred that natural gas had not been discovered in these formations, and, therefore, it may be well to quote the following passage from chapter xvii, p. 527 of the Geology of Canada, 1863, from which it will be seen that both gas and petroleum have long been known to occur over wide areas in Canada from the vicinity of Quebec to the Manitoulin Islands, and it has also long been known to occur in the Gaspé Peninsula :—

"The light carburetted hydrogen or marsh gas, which is so often a product of the transformation of organic matter at ordinary temperatures, is abundant in the palæozoic rocks of Canada and issues from many mineral springs. Those of Caledonia, Varennes and Caxton, in the Lower Silurian series, give off great volumes of this gas, which keep the waters in constant agitation. Many other less important instances of the same kind might be mentioned, while in the higher strata of western Canada this gas is still more abundant, as at the well known burning spring near Niagara Falls and in the region of the oil wells. In boring these, reservoirs of it are frequently penetrated from which the gas is liberated with explosive violence. In nearly all the oil wells there is a greater or less disengagement of inflammable gas; so that it would appear that the strata almost everywhere in that region hold, in a condensed state, portions of light carburetted hydrogen, which is discharged wherever a natural fissure or an artificial boring furnishes a vent.

It was further stated *Op. cit.* p. 788: "The possibility of its occurrence in available quantities in some parts of the Trenton formation should not be lost sight of."

During the past three or four years attention has again been directed to this question, chiefly through the great developments that have during that period been made in Pennsylvania, Ohio and other states, and several wells have been sunk in the province of Quebec with a view to develop the indications of petroleum and natural gas, which, as already stated, were long ago pointed out by the Geological Survey. The most important of these trials was made in the summer of 1885, and it seems desirable to quote here the detailed description of it by Mr. Obalski, as published, pp. 116–117, Report of the Commissioner of Crown Lands, Quebec, 1885.

GAS WELL NEAR ST. GRÉGOIRE, COUNTY OF NICOLET.

"These borings were effected on Mr. Hilaire Trudel's land (No. 501 of the Cadastre) at the south-east end of the concession of Bonséjour (Seigniory Roquetaillade). The following table gives the depths reached and the nature of the rock encountered: —

	On the surface, 31st July, 1885, 1 foot of earth, good cultivable soil, flow of odorless gas.
From 1 to 48 feet.	47 feet of blue loam, with thin layers of sand.
From 48 to 53 feet.	5 feet of white sand, with abundant emanations of odorless gas.
From 53 to 68 feet.	15 feet of heavy gravel, composed of pebbles of granite, sandstone, calcareous rock, &c., with abundant emanations of odorless gas and water.
From 68 to 75 feet.	7 feet of black sand, very dense, hard to penetrate; water, but no gas.
From 75 to 155 feet.	80 feet of solid rock, sandstone, somewhat calcareous, soft enough to be cut with a knife; oily oozings.
From 155 to 215 feet.	60 feet of same rock, but harder and of a finer grain.
From 215 to 290 feet.	75 feet of red shale, wrongly called by the miners "soapstone."
From 290 to 300 feet.	10 feet of same rock, lighter color.
From 300 to 316 feet.	16 feet of same rock, nearly black.
From 316 to 370 feet.	54 feet of blackish brown schist, not hard; abundant and sudden flow of gas, having a strong smell of kerosene.
From 370 to 475 feet.	105 feet of red shale; more abundant emanation of gas.
From 475 to 525 feet.	50 feet of red schist, somewhat greyish.
From 525 to 580 feet.	55 feet of red schist, softer.

From 580 to 640 feet. 60 feet, another flow of gas, more violent, throwing mud and stones from the bottom to a height of 60 feet in the air, and preventing work. This gas affects the sight and the lungs of the workmen; continuation of red shale.

From 640 to 660 feet. 20 feet of impure calcareous rock, apparently containing magnesia. Another vein of gas of the same nature.

From 660 to 720 feet. 60 feet of calcareous rock.

From 720 to 820 feet. 100 feet of oily calcareous rock.

From 820 to 860 feet. 40 feet of black schist, soft to the touch. New vein of the same gas.

From 860 to 1,115 ft. 255 feet of compact black schist.

1,115 feet. Work suspended. The gas continues to flow with such force that it is impossible to close the orifice, so two pipes of ½-inch diameter are fitted to the main one.

This boring has evidently passed through the Medina shales and sandstones which appear to be here 565 feet thick* and the remainder of the boring, 540 feet, seems to be in the Hudson River rocks. Below these the Utica, and the Trenton would be found, and as it is at the junction of the latter that the main gas and petroleum occurs in north-western Ohio it seems very desirable that the St. Grégoire boring should be continued till it reaches the Trenton limestone. The Ohio section shows the Medina only 80 feet thick with 305 feet of Clinton and Niagara on top, and at the base of the Medina there is a heavy flow of gas, as is the case at 640 feet deep, the base of the Medina, at St. Grégoire. Below this in Ohio are 430 feet of Hudson River strata and 275 feet of Utica shale, at the base of which, or a few feet lower in the Trenton limestone are, as above stated, the great petroleum and gas reservoirs.

An all important consideration in connection with the probable occurrence of these reservoirs is that of the geological structure of the district, and while for reasons in connection with this I have never had any faith in their occurrence on the north side of the St. Lawrence, I consider that the probability of such reservoirs existing on the south side, in the country between Lake St. Peter and St. Hyacinthe, is very great, especially along, or in proximity to, the central part of the line indicated by Sir W. E. Logan as the course of the Deschambault anticlinal.—Geol. of Canada, 1863, pp. 152, 205 and 272.

At St. Grégoire 550 feet of Hudson River strata have been penetrated. Between the Island of Orleans and the north shore of the St. Lawrence Sir W. E. Logan estimated the thickness of the Hudson and Utica at 2,000 and 300 feet respectively. Supposing them to be equally thick at St. Grégoire the boring would have to be continued 1,700 feet before reaching the Trenton limestone. A little north of St. Hilaire, on the Grand Trunk railway, however, the Trenton limestone would probably be reached at a much less depth, as the axis of the anticlinal gradually rises in that direction, and the upper measures of the Hudson River and the Medina are absent.

In any case the question may certainly be regarded as one of great importance in comparison with the small amount of money which would be required to thoroughly test it.

As regards the question of manufacturing industries in connection with natural gas as a fuel, however, I may quote the following remarks of Professor Lesley;†

"The facts in reference to natural gas wells, briefly given above, point to the conclusion that gas wells have their regular life, and that the quantity of gas is a limited amount. If a single well is down and yielding gas, the pressure will remain constant and the supply regular for many years, but as soon as new wells go down in the immediate vicinity the total gas supply is sooner or later exhausted and all the wells cease yielding gas.

"The necessary result of this would be that natural gas as a fuel for iron puddling

* The thickness of the Medina formation at the west end of Lake Ontario is given (Geol. of Canada, 1863, p 312) as 614 feet.

† Report L. 2nd, Geol. Survey of Pennsylvania, p. 171.

and other uses must be confined to the position of an economical adjunct to other fuels. That is, for works in all other respects well situated for successful iron working, with a cheap coal supply immediately available upon a temporary or permanent ceasing of the gas supply, this natural gas can be brought in as a fuel and used with heavy saving of cost. But it is highly improbable that it could ever pay to locate works simply on a gas supply in a position where without the gas the works could not be successfully run. It is therefore as an economical adjunct, and not as a main source of supply that this gas must be regarded."

In New Brunswick, work was continued during the past summer by Professor Bailey and Mr. McInnes, assisted by Mr. J. W. Bailey. Professor Bailey's attention was first directed to the examination of the country on the upper waters of the St. John River, with a view to determine the limits of the Silurian system in that direction and its relations to the so-called Quebec group supposed to underlie and flank it on the northern side. With this object in view, an attempt was made to ascend the valley of the St. John to the north-west branch, where only a short interval separates the St. John waters from those of the Etchemin River flowing to the St. Lawrence; owing, however, to the dry season and the consequent low state of the water it was found impossible to ascend further than the Seven Islands, and even this point was reached with difficulty, while the ascent of the Big Black and Little Black Rivers had to be abandoned.

Having obtained as much information as possible regarding the Silurian rocks in northern New Brunswick and in the adjacent portions of the province of Quebec and the state of Maine, it was considered advisable as a preliminary to the examination of the older rocks, hitherto known as the Quebec group, to obtain somewhat greater intimacy with the latter in the localities where they were first observed and where their typical features can be best studied.

For this purpose Professor Bailey visited Rimouski and Bic, and then carried his examination inland, till, at the village of St. Blondin, he not only found the western edge of the Silurian rocks, but that there, and in the adjacent Bois Brulé Mountains, the beds were highly fossiliferous, and from them considerable collections were made. He then visited Quebec, where Dr. Ells was engaged in similar work, and with him made a boat trip down the St. Lawrence, thus acquiring a familiarity with the rocks of the so-called Quebec group which would not otherwise have been possible, and which will greatly facilitate his further study of the similar formations in New Brunswick.

During the latter part of the season the cuttings recently made in constructing the Témiscouata railway were carefully examined, as was also the country in the vicinity of Temiscouata Lake. In the latter examination Professor Bailey was accompanied by Mr. Ami, who made a thorough exploration of the fossiliferous strata of Mount Wissick, Point aux Trembles and Lake Tuladie, and secured a number of interesting fossils, which must be critically examined before any precise correlation of the strata in which they occur can be made. The district was examined in 1849 by Sir W. E. Logan, and is described in the Geology of Canada, 1863, Chap. XVI, pp. 420–423, under the heading "Gaspé Series."

The attention of Mr. McInnes was devoted chiefly to making measurements and securing other data required for the completion of the quarter-sheet map, 17 N.E. of the New Brunswick series, on a scale of four miles to one inch. His observations extended also into the area, which will be included in the adjoining quarter-sheet, to the north. A micrometer survey was made of the north side of the St. John River from Edmundston to the mouth of the St. Francis, and of the St. Francis River and lakes, in all about 100 miles. The region to the east of the inter-provincial boundary, in Restigouche county, was examined by ascending the Green River and crossing by a portage of about seven miles to the Quatawamkedgewick, and thence by the Restigouche and Grand Rivers to the St. John. The whole of this region was found to be occupied by strata of Silurian age. Large areas of good land are

yet available for settlement in the valleys of these streams, along which there are many fine alluvial flats, with good soil on the uplands. About 250 miles of roads and streams, of which surveys were available, were traversed and examined during the season.

Mr. McInnes further reports that game, owing to the protection afforded it by law, is still fairly abundant in this region; that moose and cariboo are numerous, and that red deer have latterly been coming in in considerable numbers from the adjoining state of Maine.

During the first part of the season Mr. J. W. Bailey was occupied in making an examination of the St. Francis River and its tributaries from their sources along the line of the Temiscouata Portage road to the junction of the same stream with the St. John. He also made a detailed examination of Temiscouata, Boundary, and other lakes as to depth, physical peculiarities, &c. Subsequently he accompanied and assisted Professor Bailey during the remainder of the season.

Mr. McInnes left Ottawa for field work on the 5th of July, and returned on the 11th October. Professor Bailey was in the field from 12th July to the 21st September.

Cost of seasons exploration $1,024.61.

The geological features of this region will form the subject of a detailed report and map, which will be prepared when the observations have been studied, the fossils determined and the measurements plotted. Another season's work in the field will, however, probably be desirable before the report and map referred to are published.

Mr. R. Chalmers left Ottawa on the 12th of May for New Brunswick, to continue the examination and mapping of the surface deposits within the area embraced in the quarter-sheet maps Nos. 1 S.E. and 1 S.W., bordering the Bay of Fundy. In 1885 the area embraced in the quarter-sheet maps 3 S.E. and 3 S.W. was surveyed and the report and accompanying maps are published as Part M. of the Annual Report, 1886. During the season of 1886 Mr. Chalmers made a detailed examination of the surface deposits in north-eastern New Brunswick, in the area covered by the quarter-sheet maps 2 N.W. and 6 S.E. These latter, with the report referring to them, are now waiting to be printed. Each of these quarter-sheet maps covers an area of 3,456 square miles. Mr. Chalmers has, therefore, now examined, making allowance for water areas, about 20,000 square miles.

During the past season the work in the field was continued to the 14th December, the cost being $749.42.

Mr. Chalmers: "states that the mapping of the different superficial formations was carried out in greater detail this season than had hitherto been attempted, the more settled condition of the country affording better facilities for doing so. All the important mountains and hill features, as well as the forest covered tracts, will be delineated on the map as accurately as time and circumstances permit. The representation of the hills and ridges in western Charlotte seemed to be absolutely necessary to exhibit the character of the surface deposits. In the vicinity of St. Stephen and eastward these ridges were found to be capped with boulder-clay, while the valleys between them contain stratified materials.

"Observations with the aneroid barometer were regularly taken, based upon those of the meteorological stations at St. John and St. Andrew's, so that the heights in nearly every part of the area can be shown.

"The general character of the soil within the area under consideration is unfavorable to the successful prosecution of agriculture. Nevertheless, along all the river valleys, and more especially in western Charlotte, there are excellent, well-cultivated farms. The land is good enough anywhere when once cleared of boulders; but owing to their abundance the labor attending this is simply immense. At St. Andrew's there is a fine tract of land upon the Lower Carboniferous sandstones."

The maps and a full report will be prepared during the winter.

The explorations and surveys in Nova Scotia were conducted during the past summer, as heretofore, under the supervision of Mr. H Fletcher, who left Ottawa for the field with his associates, Mr. E. R. Faribault, Mr. J. A. Robert and Mr. McMillan, on the 5th July. Mr. Fletcher's attention was devoted to the survey and examination, in which he was assisted by Mr. Robert, of that portion of Pictou county which lies between West River and the country that is described in Part B of the Annual Report for 1886, recently published. Mr. Fletcher reports having secured the services of Mr. Donald Fraser, of Springville, to trace the outcrops of the iron ores of the East River, and to describe the various workings on them.

Besides coal and iron ore there are, within the area examined by Mr. Fletcher, workable deposits of gypsum, limestone, freestone, sand, brick clay and fire-clay. There is also a small deposit of bog-manganese in a brook at Glengarry.

The coal mines were not re-examined, but Mr. Fletcher states that "some alterations and some additions are now required in the map made by Sir W. E. Logan and Mr. Hartley, and published with the Report of Progress, Geological Survey, 1866-69.

"The iron ores of Pictou county, though not yet developed, must be regarded as next to the coal in economic importance. They are found at West River, Glengarry, Gairloch, Lorne, Bridgeville, Blanchard, Sutherland's and French Rivers, within a radius of seven miles and a half, and consist of limonite, red hematite, specular, spathic and bog ore, in such abundance, variety and purity as to astonish all visitors. The ores of the East River and Blanchard were worked sixty years ago, in a small way, by the General Mining Association. Since then much money has been expended to develop the mineral resources of the district. It presents greater facilities for manufacturing iron profitably than are to be found in any other part of the Dominion, and it offers a field in which the investment of capital, by a company having enterprise and skill, would almost certainly result in the establishment of extensive and remunerative mining and smelting works, for the production of nearly all the grades of iron that are now imported. Pictou county is as favorably situated as are the best ore producing districts of Pennsylvania. There is a large market in the Dominion, as is shown by the value—nearly fifteen million dollars in 1886—of the iron and steel in various forms annually imported, much of which might be made in the country, labor being plentiful and cheap.

"The iron ores are in veins and in beds, varying in thickness from mere threads to one hundred feet. They crop out on hills and in bluffs, and the mines could be worked and drained by an adit to a depth, in most cases, of 200 to 300 feet, so that for some time to come neither pumping nor hoisting machinery would be required.

"The limonite, which yields 65 per cent. of metallic iron, is associated with manganese in quantity, thus strongly resembling the limonites that are brought to England from Spain to be used in the manufacture of spiegeleisen, manganeisen and steel. The percentage of iron in the other ores is variable, but all are of workable richness. The Pictou coal is free from sulphur and yields a firm, excellent coke. Limestone for flux is in close proximity and can be quarried cheaply in any required quantity."

A short and easily constructed branch railway would connect all the mines and the works with the Intercolonial main line, which now passes the coal mines, to an excellent shipping port on Pictou Harbor.

Cost of seasons exploration $1,500.

Mineral Statistics.

Mr. Coste, Mining Engineer to the Geological Survey, has been engaged during the past year in collecting the material for, and in preparing a statistical report on the exports and imports and on the production of minerals in Canada in 1886, and, when the information was available, for some previous years also. This report, covering 85 pages, forms Part S of the Annual Report of the Geological Survey, Vol. II, new series 1886. It is also published separately and sold for twenty-five cents.

The articles relating to salt and silver were prepared by Mr. E. D. Ingall, Mining Geologist of this Branch.

Mr. Coste was ably assisted throughout by Mr. H. P. Brumell. He was further greatly aided, and the work was much lightened and expedited by the readiness evinced in all quarters to send in returns and answer enquiries, while but for the information afforded by the Department of Mines in British Columbia and by Mr. Gilpin, Chief Inspector of Mines in Nova Scotia, it would have been impossible to have completed the returns for those provinces.

Mr. Coste states that "about 2,000 forms and 400 letters were sent and 665 forms and 185 letters were returned. Plans of twenty different mines were secured and copied.

With a view to prepare for 1887 a more detailed and complete report on the mining resources and industries of the country than that now presented, the following places were visited during the summer by Mr. Coste in order to make personal examinations and enquiries:—

Port Arthur, Sudbury, Bristol Mine and places on the Kingston and Pembroke railway, Perth, Capelton and Montreal.

During these visits Mr. Coste observed "that in several districts the mining operations were being pushed with more vigor and success than during the previous year, especially in the Port Arthur silver district, along the Kingston and Pembroke railway line, at the Bristol iron mine, in the phosphate districts and at the Capelton copper mines. A wonderfully rich ore body was discovered in March of this year at the Beaver silver mine and in July was exposed in four different levels. Ninety to 100 tons of selected ore had been secured, which gave an average of $1,500 to the ton; 1,400 tons of rock, averaging by assay $40 per ton, had been treated in the mill and had been reduced to about fifty tons of concentrates, averaging by assay $1,000 per ton. On one day in July assays of the mill rock gave $85 and the concentrates $2,300 per ton.

In the district along the Kingston and Pembroke railway and at the Bristol iron mines Mr. Coste observed a marked "renewal of activity in the working of the iron mines by two strong companies."

"Some of the Canadian ores, it is true, contain a high percentage of sulphur, but so do the similar iron ores of New Jersey, in some instances as much as $\frac{2}{4}$ per cent., and yet these ores are mined in large quantity. In 1880, there were 112 mines being worked in New Jersey, which produced 739,369 tons of ore. An analysis of the average ore of the Sulphur Hill mine gave 2·527 per cent. of sulphur. This ore was used in the company's furnace at Chester, N.J., but was first roasted in Taylor's patent gas kilns, and it is stated that in a sample taken from 100 tons of the roasted ore only 0·786 per cent. of sulphur could be detected.*

These facts are given by Mr. Coste to show that there is no apparent reason why the same treatment could not be successfully applied to the sulphurous Canadian ores, and he states that the experiment is now being tried by the enterprising Ottawa capitalists who are working the Bristol mine, and who last summer erected two large Taylor-Langdon gas kilns to roast their ore before shipment. Should this prove successful it will probably lead to the further development of a number of large deposits of iron ore that have hitherto beer neglected.

At the Capelton copper and sulphur mines some extensive new works were in progress both at the mines and near the railway station. At the latter, large new sulphuric acid works, nearly completed, and fitted with the best improvements, were being built by the present owners of the Albert, Hartford and Capel mines, Messrs. G. H. Nichols & Co., of New York. At the mine, also, extensive preparations for working on a larger scale were being made. These included the erection of a large crushing and concentrating plant, two new boilers, a pumping station three-quarters of a mile from the mine, a powerful hoisting engine, two air compressors and two shaft houses with corresponding well constructed skip roads. The old Albert, or present No. 1 shaft will also be repaired. It is now about 810 feet deep, and the vein is, on the whole, stronger in depth than it was nearer the surface. This is also the

*Tenth Census of the United States. Vol. XV, pp. 145-147.

case in the Crown mine, which is further west on the same vein, and continues in active operation, the shaft having now reached a depth of more than 1,500 feet. Nearly 44,000 tons of ore were exported from these two mines (Albert and Crown) to the United States in 1886. The ore is an argentiferous iron and copper pyrites, very similar to, but holding a larger percentage of both copper and silver than that of the celebrated Huelva district in Spain, whence 550,000 tons were exported to England in 1886, valued at a little more than one million sterling. *

The cupriferous pyrites of the Eastern Townships contains as much sulphur as the Spanish pyrites and is, as stated, richer in copper and silver. If it could be introduced into England at the same price, about ten dollars per ton, there seems no reason why it might not compete successfully with the Spanish ores, and thus lead to the development of other valuable mines in the Eastern Townships.

In the phosphate mining industry Mr. Coste states "there is a renewal of activity in the Ontario district, where two promising properties are being worked by Capt. Boyd Smith, and by the Anglo-Canadian Company. In Quebec, Ottawa county, the mines continue to be actively worked and the production this year will probably be greater than in 1886." The introduction of Canadian phosphate in the United States is likely to become an important feature of the industry and to afford a large and profitable market.

Some hesitation and distrust is still noticed among many of the phosphate miners. This arises from the often irregular nature of the deposits, and from an idea at one time somewhat prevalent that most of the deposits were mere surface pockets. In this respect, however, there is no reason for supposing that the deposits of phosphate differ from those of iron ore or of any of the other associated minerals, and thus while some of the deposits may be quickly exhausted, others will be permanent to the greatest depth to which mining operations can be profitably carried.

During the summer Mr. Brumell was requested by Mr. Coste to visit localities in the counties of Essex, Lambton and Brant, in Ontario. He also spent five weeks in New Brunswick, in King's, Queen's, Westmoreland, Charlotte, York, Sunbury and Northumberland counties.

Early in October he was sent to examine into a reported discovery of coal at Campbellford in Ontario. The report, as was well known it must, turned out to be unfounded, the country there being all occupied by the Trenton limestone formation.

On the 13th of Oct. M. Brumell went to Lake Temiscaming, but owing to the steamer on the lake being disabled was unable to effect anything or to visit the mines.

Field expenses of Messrs. Coste and Brumell $1,088.40.

Chemistry and Mineralogy.

The report furnished by Mr. Hoffmann on the work carried out in the chemical laboratory includes that in connection with the mineralogical section of the museum, to the arrangement of which much time and care has been devoted by Mr. Hoffmann, and as a number of new specimens has been added to the collections, considerable extension and re-arrangement of the cases has been necessary.

Mr. Hoffmann reports as follows:—

"The work carried out in the chemical laboratory during the past year may be said to have an almost exclusive economic character. It included:—

"I.—Analyses of numerous specimens of lignites, lignitic coals and coals from the North-West Territoriy and British Columbia. Of the coals examined from the last named province, three were from seams of considerable thickness, and proved to be of very superior quality.

"II.—Analyses of iron and copper ores.

"III.—Analyses of mineral waters.

* Mining Statistics of the United Kingdom, 1886.

"IV.—Gold and silver assays. The number of these assays made in the laboratory during the period above specified amounted to one hundred and forty-eight, and exceeds that of any previous year.

"V.—Miscellaneous examinations, embracing chromic iron ore, clay, &c., &c.

"In the last summary report of this section mention was omitted of the following additions to the list of minerals previously known to occur in Canada, viz., cookeite, uraninite, monazite and smaltite. They have, however, been fully referred to in Part T, Annual Report, 1886. The second mentioned, uraninite or pitch-blende, constitutes the principal ore of uranium, and is of economic importance, being employed in chemical operations, for painting on porcelain, and glass staining.

"The number of mineral specimens received for examination amounted to six hundred and ninety-eight, as compared with five hundred and forty-six for 1886, and three hundred and thirty-nine for 1885. A large proportion of these were brought by visitors desirous of obtaining information in regard to their economic value, and this was in most instances communicated in the course of a personal interview. In many cases, however, a more than cursory examination was called for, and the results were subsequently communicated by letter. Notwithstanding that correspondence has been as far as possible limited to the writing of only such letters as were absolutely necessary for the conveying of information in regard to the results of examination, analysis, assay, or economic value of mineral specimens, it shows a marked increase over that of preceding years. Altogether the time devoted to visitors and correspondence has been very considerable. The number of letters written amount to two hundred and seventy-seven, as compared with one hundred and seventy in 1885.

"The mineral specimens collected by Dr. G. M. Dawson in the Upper Yukon district are under examination, and the two mineral waters from Harrison Springs, B.C., collected by yourself will now shortly be submitted to analysis.

"Mr. F. D. Adams has, (with the exception of about three months and a-half during the summer, when he was engaged in field work in the counties of Montcalm and Joliette, in continuation of work commenced in the season of 1885) in the capacity of assistant chemist, rendered excellent service, amongst other work conducted by him being that of the analysis of the water of one of the principal thermal springs at Banff.

"Mr. E. B. Kenrick worked faithfully and diligently as junior assistant chemist up to the end of August, when he left to accept a professorship at St. John's College, Winnipeg. The position occupied by him has since been filled by Mr. R. A. A. Johnston, an earnest worker.

"In the mineralogical section of the museum some of the specimens have been replaced by better ones of the same kind, and one hundred and twenty-six new ones have been added. These include the following presentations:

Allan, W. A., Ottawa:—

Crystal of apatite from the Emerald mine, township of Buckingham, Ottawa county, Q. This crystal weighs five hundred and fifty pounds, and has a circumference of seventy-two and a half inches. It is supposed to be the largest crystal ever found in any country.

Muscovite, with inclusions of garnet, from the Villeneuve mica mine, Villeneuve, Ottawa county, Q.

Native silver from mining location R. 238, north of Atik Lake, west of White Fish Lake, Thunder Bay, Lake Superior, Ont.

Chisholm, Duncan, Salt Springs, N. S.:—

Brick-clay and bricks from Salt Springs, Antigonish county, N. S.

Copeland, J. S., Merigonish, N. S.:—

Infusorial earth from Merigonish, Pictou county, N. S.

Daly, Thomas:—

Phlogopite, from the township of Portland, Ottawa county, Q.

Egan, H. L., Ottawa :—
Magnetite, from the township of Litchfield, Pontiac county, Q.

Haycock, E. B., Ottawa :—
Uraninite, from the township of Villeneuve, Ottawa county, Q.
Monazite, from the township of Villeneuve, Ottawa county, Q.

Hanks, Prof. H. G., 543, Clay street, San Francisco, Cal., U.S.
A fine specimen of the new anhydrous sulpho-carbonate of sodium, "hanksite"; also well-crystallized specimens of glauberite.

Keefer, T. A., Port Arthur, Ontario :—
Zinc blende, from the Zenith zinc mine, north shore of Lake Superior, Ont.

Lemieux, Joseph, Ottawa :—
Hematite from Iron Island, Lake Nipissing, Ont.

McCool, James, Mattawa, District of Nipissing, Ont.
Apatite, from the township of Ferries, district of Nipissing, Ont.

McDonald, R., & Sons, Arnprior, Ont.;—
Polished column and base of Arnprior marble, the stone having been taken from their quarry in the township of McNab, Renfrew county, Ont.

Mackenzie, Alexander, Montreal, Q. :—
Gold-bearing rock from the Crow's Nest mine, Guysborough county, N. S.

McLaurin, J., Templeton, Ottawa county, Q. :—
Phlogopite, from the township of Templeton, Ottawa county, Q.

McNeely, J. L., Carleton Place, Ont. :—
Hematite, from the township of Beckwith, Lanark county, Ont.
Copper pyrites from the township of Beckwith, Lanark county, Ont.

Moore, Isaac, Ottawa:—
Copper pyrites, from the south-east side of Straight Lake, district of Algoma, Ont.

Murphy, W. H., Ottawa :—
Zinc-blende from the township of Calumet, Pontiac county, Q.

Poole, H. S., Stellarton, N. S. :—
Carboniferous conglomerate carrying native gold, from Gay's River, Colchester, N.S.
Altered bitumen, from the *falls measures* immediately overlying the Acadia seam at Westville, Pictou county, N.S.
Anglesite, from the Big Dome Mine, Arizona.

Shea, Dennis, Bryson, Pontiac county, Q. :—
Zinc-blende, from the township of Calumet, Pontiac county, Q.

Toronto Stone Company, Toronto :—
A dressed cube of the dolomite from Pelée Island, Lake Erie, Ont.

Van Horne, W. C., V. P. Canadian Pacific Railway, Montreal :—
Copper pyrites, from Sudbury, district of Nipissing, Ont.

Wild, General E. A., Port Arthur, Ont.
Silver glance, from the Rabbit Mountain mine, Thunder Bay, Lake Superior, Ont.

Wright, G. B., Victoria, B. C. :—
Silver ore from four different claims, Illecillewaet, Selkirk Range, B.C.

"Mr. R. L. Broadbent was for the space of eight months engaged in the prosecution of the work of permanent labelling of specimens in the mineral collection, re-adjusting the contents of some of the cases, and the maintaining of the same in an orderly condition. During the remaining months he was occupied in writing labels, under the direction of Mr. Whiteaves, for the biological section of the museum.

Mr. C. W. Willimott has labelled and catalogued a large number of the specimens which are exhibited in the yard of the museum. These specimens consist, in part, of such as cannot by reason of their size or nature, be accommodated in the museum, and of others, such as building stones, &c., upon which it is desired to ascertain the action of atmospheric influences. He has also been occupied in making up mineral and rock collections for various educational institutons, &c.

" Collections of this description have been forwarded to :—

	Specimens.
Depart. de Olras Publicas Republica Argentina, for exchange..	119
James Edmunds, London, England	42
St. Joseph Philosphical and Theological Seminary	105
Halifax Teachers Class and Halifax Academy	105
Professor J. G. Bonney, London, England	41
Captain Douglas.	4
Canadian Pacific Railway (for exhibition at the Liverpool Exhibition)	75
Professor H. A. Ward of Rochester, N. Y. (in exchange for specimens required for the museum)	81
	533

" Collections for the following will be ready in a few days :—

	Specimens.
J. C. Tremblay, Chicoutimi	115
High School Board, Aylmer	115
University of St. Joseph, Memramcook, N.S.	115
Christian Brothers training school, Clonmel, Ireland	115
St. John's College, Winnipeg	115
Canadian Institute, Toronto	115
	1,223

" Collections for the following have yet to be made up :—
W. Smith, Land and Works Department, B.C.
Royal Military College, Kingston, Ont.
College Bourget, Rigaud, P. Q.

" In the course of the summer Mr. Willimott visited the townships of North Burgess Ramsay, Darling, and Ross in Ontario, and Oxford, Chatham, Grenville, Villeneuve, Wakefield, and Hull, in the province of Quebec, for the purpose of procuring certain mineral specimens required for the making up of collections for educational purposes. Whilst so engaged he collected many specimens superior to those already in the museum collection, which they will replace, and in addition some other highly interesting ones, such as tourmaline in various stages of alteration, a mineral which may prove to be lepidolite, as also specimens of the monazite and uraninite of which mention was made at the commencement of this report."

Palæontology and Zoology.

In this division Mr. Whiteaves reports as follows:—" The illustrated synopsis of the fossils of the Hamilton Formation of Ontario, with descriptions of some new species, to which reference was made in the Summary Report of last year, has been published and distributed. The fossils collected by Dr. G. M. Dawson in 1885 from the Mesozoic rocks of the northern part of Vancouver Island and adjacent coasts have been studied, and a critical list of the species, with descriptions of such as are believed to be new, has been prepared and published as an appendix to Dr. Dawson's report on

the geology of that district. An interesting series of fossils collected by Mr. J. B. Tyrrell in 1885 and 1886 from the Cretaceous and Laramie deposits of the valleys of the Saskatchewan and its tributaries has also been studied, and a similar list of species, with descriptions of several new forms, has been printed as an appendix to Mr. Tyrrell's report on Northern Alberta. A paper descriptive of the whole of the fossils at present in the Museum of the Survey from the Triassic rocks of British Columbia has been written during the year, but its publication has been deferred in consequence of the recent receipt from Mr. McConnell of some additional species collected by him during the summer from deposits on the Liard River which are evidently of Triassic age, a description of these species being deemed essential to the completeness of this presentation of the subject. The generic and specific affinities of these fossils from the Liard River, however, have been for the most part ascertained, as have those also of a small but remarkable assemblage of species recently collected by Dr. Dawson from the Cretaceous rocks of the Lewis River, a tributary of the Yukon. A preliminary examination has been made of a series of Cretaceous and other fossils obtained during the year by Mr. Tyrrell from the Duck and Riding Mountains in northern Manitoba.

"Considerable alterations and improvements have been made in the upper flat of the museum. The more important of these consist of the construction of six large new upright wall cases, three for the reception of fossils, two for recent shells, and one for birds. One of these new wall cases is now filled with the remains of vertebrata from the Post Tertiary and Tertiary deposits of Canada, which have been skillfully re-arranged by Mr. T. C. Weston. To this series an important addition has been made during the year in the shape of a lower jaw, with several vertebræ, ribs and limb bones of a *Mastodon*, which was discovered some years ago in a peat bog near Woodstock, Ont. In two of the other new wall cases the larger fossils of the Carboniferous and Permo-Carboniferous rocks of the Lower Provinces are now displayed to much better advantage than heretofore, these specimens also having been judiciously re-arranged by Mr. Weston. Two others have been devoted to the exhibition of a number of recent shells, of large and comparatively large size, many of which have been recently acquired by exchange. The whole of the shells in these new cases, and in another of similar size, have been neatly labelled by Mr. R. Broadbent, under Mr. Whiteaves' directions, the number of labels required for this purpose being 377. Mr. Broadbent, who has worked in this department for four months, has also labelled each specimen in the extensive series of recent mollusca from the Pacific coast of Canada now in the museum, so that the duplicates can be more readily distributed to educational institutions, and has placed upon exhibition in the cases a number of additional specimens. The last of the five new cases now contains 112 specimens of Canadian birds belonging to the family Oscinæ, very few of which had previously been exhibited.

"On the 31st of December, 1886, there were 44 mounted specimens of Canadian mammals and 142 of Canadian birds on exhibition in the museum. On the 23rd of December, 1887, the number of mounted specimens on exhibition was, mammals, 82, (including a fine example of a puma shot in August last near Victoria, Vancouver Island); and birds, 352; many of which have been set up by Mr. Herring during the year. To most of these specimens a provisional label has been attached.

"The number of letters written is a little over 200; and for rather more than three months, in the absence of the Director on field work, the duties of Acting Director, as on several former occasions, have devolved on Mr. Whiteaves.

Mr. Weston reports that since the 30th of December, 1886, he has spent about three months in arranging, cataloguing and labelling several hundred ethnological specimens. He has also prepared about 150 microscopic sections of rocks from various formations. Between 13th June and 17th September, 56 days were devoted by him to field work and to the examination of many fossil localities between Cape Rosier and Point Lévis. In this exploration Mr. Weston was assisted by Mr. L. M. Lambe. A few days were subsequently spent in collecting fossils at Grimsby, Ont. Through the kindness of Mr. R. Thompson, of Grimsby, an unusually fine example of

Arthrophycus (or *Harlania*) *Harlani* was secured for the museum. The rest of Mr. Weston's time has been occupied in museum work in the palæontological department.

Mr. H. M. Ami reports that during the earlier portion of the past year he was engaged in determining, classifying and labelling the large series of Silurian fossils collected by Mr. Weston in 1886, at various localities on the Arissaig shore, at Cape George and at Lochaber Lake, and in Antigonish county, N. S., from rocks which range in age from the Medina to the Lower Helderberg. He has also determined the Graptolites collected by Dr. Selwyn at Matane and has helped Mr. Whiteaves in the examination of some Devonian fossils from Western Ontario. He has prepared systematic lists of labels, which have since been printed, for the fossils of the Hamilton Formation of Ontario enumerated in Mr. Whiteaves' "Contributions to Canadian Palæontology," Vol. 1, part 2, and for the graptolites of the Lévis Formation. Collections from the duplicates in the museum have been selected and labelled by him and sent to the following institutions or persons :—(1) To Laval University, Quebec, fossils; (2) to Mr. W. B. Clark, of Johns Hopkins University, Baltimore, fossils, in exchange for other specimens; and (3) to the Rev. Hector Currie, of Thedford, Ont., recent shells in exchange for Devonian fossils. Small collections, for special purposes, have also been forwarded for examination to Messrs. G. F. Matthew, E. O. Ulrich and C. D. Walcott. During the month of September and part of October, Mr. Ami was engaged in assisting Dr. Ells and Professor Bailey in their field explorations of various parts of the province of Quebec, by collecting fossils with a view to ascertain the exact geological horizon of the rocks from which they were obtained. Since his return from the field he has examined the somewhat extensive collections of Natural History specimens of various kinds which Mr. D. N. St. Cyr brought to Ottawa for identification, on behalf of the Quebec Government. These collections are intended to form the nucleus of a museum in connection with the Department of Instruction at Quebec, and consist of a large series of Canadian fossils, mostly from the province of Quebec, and numerous species of marine, land and fresh water shells, with other invertebrata, from the gulf or valley of the St. Lawrence, exotic shells and the like. These collections have since been named, labelled and catalogued by Mr. Ami, under the supervision of Mr. Whiteaves, and duly forwarded to Quebec.

As in previous years, the whole of the drawings required for the illustration of palæontological reports have been carefully and skilfully prepared by Mr. L. M. Lambe

The following collections have been received during the year from members of the staff or from gentlemen engaged in the work of the Survey :—

Dr. A. R. C. Selwyn :—
About 60 specimens of graptolites from the shales of the Lévis formation at Matane, Q.

Dr. R. Bell :—
About 250 specimens of fossils from the Silurian rocks of Lake Temiscaming.
One skin of a black hare from Paish-ko-tchagami Lake.
About 120 specimens of coleoptera and 50 of lepidoptera from the Upper Ottawa region, extending from Temagami Lake and the Montreal River to the source of the Ottawa River, due north of Ottawa.
One Star-nosed Mole (*Condylura cristata*) from Ottawa.
One Jumping Mouse (*Zapus hudsonius*) from the Albany River.

Dr. G. M. Dawson :—
One Field Mouse (*Arvicola riparia*) from Finlayson Lake, Liard River, N.W.T.
One Red Squirrel (*Sciurus Hudsonicus*) from the Yukon River at the confluence of the Lewis and Pelly.
One Northern Flying Squirel (*Sciuropterus volucella* var. *Hudsonicus*) from Chilkoot Inlet.
One Spotted Sandpiper (*Actitis macularia*) from the Cassiar district, B.C.

One Northern Pacific Kittiwake (*Rissa tridactyla, pollicaris*) from Frances Lake, N.W.T.

A small series of fresh water shells, including some remarkable varieties of *Limnæa ampla*, from Frances and Finlayson lakes and the Lewis River.

Several specimens of graptolites from the presumably Cambro-Silurian shales of the Dease River, and thirty-five specimens of fossils from the Cretaceous rocks of the Lewis River.

Dr. R. W. Ells:—

A series of about 50 specimens of fossils from the Lévis Formation at various localities in the province of Quebec.

Dr. R. W. Ells and H. M. Ami:—

Forty specimens of fossils from the Chaudière River, Q., near the railway bridge.

Twenty specimens of fossils from the Hudson River formation near St. Nicholas, Q.

About twenty specimens of fossils from Point Lévis and South Quebec.

Several fossils from Champlain Street, and foot of Citadel Hill, Quebec.

About twenty fossils from the Montmorency River, and the same number from Bois Brûlé and St. Blondin, Q.

Prof. John Macoun:—

Fifty-six species of birds, represented by 90 skins, and two mammals, from Vancouver Island; also a large number of marine shells and other invertebrata, and of land and fresh water shells, from the same locality.

R. G. McConnell:—

An interesting series of fossils from the Triassic and Cretaceous rocks of the Liard River.

J. B. Tyrell and D. B. Dowling:—

450 specimens of Cretaceous fossils, twenty-four of butterflies and three of mammals from Duck and Riding Mountains, in northern Manitoba.

Professor L. W. Bailey:—

Fossils from the Beccaguimic River, N. B., from various places around Lake Temiscouata, Q., and from Bois Brulé and St. Blondin, Q.

T. C. Weston:—

About 1,000 specimens of fossils collected at various localities between Cape Rosier and Point Lévis, Q., and about 300 specimens of forty species of Niagara fossils from Grimsby, Ont.

H. M. Ami:—

Collections of fossils from Pointe aux Trembles, Mount Wissick, Tuladi River, Tuladi Lake and other places near Lake Temiscouata.

W. McInnes:—

Silurian fossils from rocks south of Rimouski, Q.

H. P. Brumell:—

Five specimens of fossiliferous Trenton limestone from Campbellford, Ont.

The additions to these departments of the museum, by presentation and purchase, are as follows:—

By Presentation:

Charles E. Fish, St. John, N. B.:—

Specimen of *Lepidodendron Sternbergii*, from the Millstone-grit of Newcastle, N. B.

J. W. Tyrrell, Weston, Ont.:—
One female "Blue" Fox, *Vulpes lagopus*, var. *fuliginosus* (trapped January 12 h, 1886); one Arctic Fox, *Vulpes lagopus*, in winter coat; one Ringed Seal, *Phoca fœtida*, (something under a week old); two Hudson's Bay Lemmings, *Cuniculus torquatus*; one Polar Hare, *Lepus timidus*, var. *arcticus*, in winter coat; all from Ashe Inlet, Hudson's Strait.

G. Seifert, Fabrique St., Quebec:—
Three specimens of the Fresh-water Pearl mussel (*Margaritana margaritifera*) with a number of pearls from the same species.

W. F. Whitcher, Ottawa:—
Skin of Kit Fox (*Vulpes velox*) from Antelope Lake, Assiniboia.

Professor E. Hull, Director Geological Survey of Ireland, Dublin:—
Two specimens of *Oldhamia antiqua* from Carrick Mountain, Wicklow, and two of *Oldhamia radiata* from Bray Head, Wicklow.

H. Bartlett, Ottawa:—
Specimen of an Osprey (*Pandion haliætus carolinensis*) shot on the Rideau River near Ottawa.

W. P. Lett, Ottawa:—
One Sora Rail (*Porzana Carolina*) also shot on the Rideau River near Ottawa.

Sir William Dawson, C.M.G., &c.:—
Specimen of *Flustra serrulata*, Busk, from Murray Bay.

T. G. White, Ottawa:—
Four specimens of Wilson's Meadow Mouse (*Arvicola riparia*) from near Ottawa.

W. J. Baylay, New Edinburgh:—
One adult female of the Marsh Harrier (*Circus Hudsonicus*) shot at Britannia Bay, near Ottawa.

D. N. St. Cyr, Department of Public Instruction, Quebec:—
One young Harp Seal (*Phoca Groenlandica*) apparently about five or six weeks old.
Specimen of *Hippopus maculatus*.

H. L. Poole, Manager Acadia Coal Mines, Stellarton, N.B:—
Fine specimen of *Lepidodendron personatum* from the coal measures at Westville, Pictou Co., N.S.

Percy Woodworth, Kentville, N.S.:—
Six specimens of insects and two fœtal mice, from Digges Island, Hudson's Bay.

W. F. MacKay, Fort Albany, James' Bay:—
Three specimens of birds from the Albany district.

By Purchase:—

Head of adult Bull-walrus (*Odobœnus rosmarus*) and skin of a White Wolf (*Canis lupus*, var.), both from Ashe's Inlet, Hudson's Strait. The walrus was shot on the 10th of April, 1886, was eleven feet long and weighed about 25,000 lbs. The white wolf was shot by an Eskimo in the winter of 1885-86, about 30 miles north of Ashe Inlet, or in Lat. 63° N., and Long. 71° 30 W.

Underjaw (with two teeth in place) vertebræ, ribs and limb-bones of *Mastodon* found in 1871 in a peat bog near Woodstock, Ont.

Specimen of an adult female Puma (*Felis concolor*) shot in August, 1887, near Victoria, V. I.
One Red Fox (*Vulpes vulgaris*).
One Kit Fox (*Vulpes velox*) from near Calgary, N.W.T.
One young Whooping Crane (*Grus Americana*) and one adult Franklin's Gull (*LarusFranklini*) both from Manitoba.
Remarkable colour variety of the Rough-legged Buzzard (*Archibuteo lagopus*) shot near Ottawa.

Botany.

On the work in this section during the year, Professor Macoun reports as follows:—"In January, February and March, I was occupied with correspondence and in examining and classifying a very large quantity of miscellaneous cryptogamic matter.

"My results have since been submitted to specialists and their partial reports are now in my hands.

"The collection of Canadian Fungi, upwards of 600 species, now in the Museum has been named by Mr. J. B. Ellis, of Newfield, N.J.

"Dr. Nils Conrad Kindberg, of Lusköping, Sweden, has examined the mosses, and has confirmed, or corrected my determination, and the list of Canadian mosses has been increased to nearly 600 species, many of them new, not only to Canada, but to science. The Hepaticæ or Liverworts are difficult to determine, but good progress is being made in this work. More than 100 species are now in the hands of Mr. Pearson, of Manchester, who is the highest authority in England on this class of plants.

"On the 8th of April I left Ottawa for Vancouver Island, arriving there on the 15th. From that time to the end of August I was occupied in collecting specimens of the flora of the island and in determining the distribution of its forest trees and the character of its soil as indicated by the vegetation.

"My researches extended from Victoria to Comox on the east coast, with frequent excursions to points in the interior. Crossing from Qualicum to Alberni I went in a canoe to Cape Beall on the outer coast. The islands in Barclay Sound were examined, and in prosecuting the examination of the country inland the following mountains were ascended:—

	Feet.
Mt. Erskine on Salt Spring Island	1,275
Mt. Finlayson near Goldstream, Vancouver Island	1,350
Mt. Benson at Nanaimo	3,363
Mt. Prevost at Somenos	2,700
Mt. Arrowsmith near Qualicum	5,976
Mt. Mark at Horne Lake	3,080

Fifteen hundred species of plants were collected.

Since my return in September I have been fully occupied sorting and determining the specimens collected during the summer, and in writing the fourth part of the Catalogue of Canadian Plants, a portion of which is now passing through the press.

During the year 1886–87 there were placed in the Herbarium 4,305 sheets of specimens, as follows:

Canadian	752
American	1,807
European	750
Cryptogams	996
	4,305

From the herbarium 5,905 sheets of duplicate specimens were distributed either to individuals in exchange for specimens received, or to scientific institutions. Among the latter were the British Museum, McGill and Queen's Colleges in Canada, and the Harvard University herbarium in the United States.

Dr. Dawson has brought back from his last summer's field of labor on the Upper Yukon a valuable and interesting collection of plants, and although but a cursory examination has been made of them, they show conclusively that the summer climate there is neither cold nor wet.

Mr. J. A. Macoun acts as botanical assistant during the winter and takes care of the herbarium, while during the summer he accompanies one or other of the exploring parties in the field, taking every opportunity to make botanical and zoological observations and collections. Besides the botanical work here recorded, Professor Macoun made valuable zoological collections during the summer which are referred in the report on that section by Mr. Whiteaves.

MAPS.

British Columbia.—The map of the western part of Vancouver Island and adjacent coast, scale eight miles to one inch, has been published with Part B of the Annual Report, 1886.

Mr. Bowman during the year has completed the following maps and plans:—

	Area in Square Miles.
1. Revised map of the southern interior of British Columbia, scale eight miles to one inch	28,914
2. Map of Cariboo district, scale two miles to one inch, about	2,720
3. Plans of eleven creeks showing placer mines and quartz ledges and embracing together about 249½ square miles, as follows:—	
(1.) Little Snowshoe and Keithley Creeks, scale 2½ inches to 1 mile	54
(2.) Sugar, Hardscrabble and Slough Creeks, 3 inches to 1 mile	49
(3.) Antler Creek, scale (about) 26 chains to 1 inch	38
(4.) Cunningham Creek do 27½ do do	34
(5.) Lightning Creek do 400 feet do	17
(6.) Grouse Creek, scale do 25 chains do	14
(7.) Island Mountain and Mosquito Creek, scale (about) 480 feet to 1 inch	3½
(8.) Harvey Creek, scale (about) 19 chains to 1 inch	3½
(9.) Williams Creek, scale do 400 feet do	12
(10.) Hixon Creek, scale 2½ inches to 1 mile	24
(11.) do do about 10 chains to an inch	⅝

North West Territory.—Mr. J. B. Tyrell's map of the country between the Upper Bow and the North Saskatchewan Rivers is engraved and accompanies Part J., Annual Report, 1886; scale 8 miles to 1 inch; area 45,000 square miles.

Manitoba and Western Ontario.—The map of the Lake of the Woods to illustrate Mr. Lawson's report on that region was published early in the year; scale 2 miles to 1 inch; area 3,456 square miles.

Mr. E. D. Ingall's map of Silver Mountain and vicinity is engraved; scale 20 chains to 1 inch; area 45 square miles. Also sketch map of Thunder Bay mining region; scale 4 miles to 1 inch; area 3,000 square miles.

Mr. Cochrane has continued the revision of sheet 115 in the field from 17th July to the 2nd September, having examined and corrected about 250 square miles. Copies were made of about 55 miles of the plans of the Wellington, Grey and Bruce railway; scale 200 feet to 1 inch.

Mr. Coste has a plan of the townships of Madoc and Marmora, county of Hastings, ready for publication. Scale 2 miles to one inch.

For two weeks during the summer Mr. Barlow was engaged surveying roads, range lines, &c., to aid in the compilation of the map of Carleton county. Scale 4 miles to one inch.

Quebec.—The south east ¼ of the Eastern Townships map is completed and will accompany Part J Annual Report, 1886. Scale 4 miles to one inch. Area 4,500 square miles.

Professor Bailey and Mr. McInnes are working on ¼ sheets, 17 N E.and 18 S.E.

The map of Ottawa and Pontiac counties remains as last reported.

New Brunswick. ¼ sheet, No. 2, N.W., has been published. Scale 4 miles to one inch. Area 1,512 square miles.

Nova Scotia. ¼ sheets, No. 4 N.E. and 4 S.E. are being drawn.

LIBRARY.

Dr. Thorburn reports that 5,075 copies of the various publications of the Survey were distributed during the year, including Annual Reports, special reports and maps. Of these 3,980 were distributed in Canada, the remainder were sent as exchanges to scientific and literary institutions and individuals in the United States, South America, Europe, India, China, Japan, Australia, &c.

The number of reports in French sent out was 563.

There were received as exchange during the past year 1,027 publications, including reports, transactions, proceedings, memoirs, periodicals, pamphlets, and maps.

There were added to the Library during the year 82 publications by purchase, besides 37 scientific magazines and periodicals on geological, mineralogical and natural history subjects subscribed for.

The number of volumes bound was 281.

The letters received in connection with matters relating to the Library and the distribution of the geological publications were 1,211, whereas those sent out during the same period were 1,315.

VISITORS.

The number of visitors to the Museum during the year from the 1st of January to the 31st of December was 17,575 or three thousand more than in any previous year.

STAFF, APPROPRIATION, EXPENDITURE AND CORRESPONDENCE.

The strength of the staff at present employed is 53, viz., professional 36, ordinary 17.

During the calendar year the following appointments were made to the permanent staff:—

Mr. Eugène Coste, Mining Engineer.
Mr. Amos Bowman, Field Geologist.
Mr. A. C. Lawson, do

The amount available for the fiscal year ended 30th June, 1887, was:—

Civil-list salaries, appropriation.....	$40,650 00
General purposes do	56,995 32
	$97,645 32

The expenditure may be summarized under the divisions named as follows:—

Civil-list salaries	$38,450 00
Wages, temporary employés	19,765 88
Exploration and survey	19,144 58
Indian and Colonial Exhibition	5,700 83
Printing and lithography	11,389 02
Purchase of specimens	865 05
Purchase and binding of books and purchase of instruments	525 83
Laboratory apparatus and chemicals	89 06
Stationery, mapping material and Queen's Printer	1,087 21
Incidental and other expenses	2,286 47
	$99,303 93
Less paid in 1886	8,837 48
	$90,466 45
Advance to field explorers and others on account 1887–88	3,930 44
Unexpended balance civil-list appropriation	2,200 00
Unexpended balance of contingency appropriation	1,048 43
	$97,645.32

The correspondence of the branch shows a total of 8,489 letters sent, and 5,505 received, from 1st January to 31st December, 1887.

I have the honor to be, Sir,

Your obedient servant,

ALFRED R. C. SELWYN,
Director.

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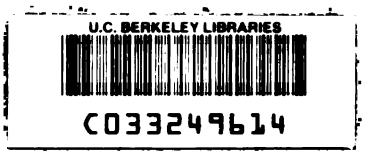
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